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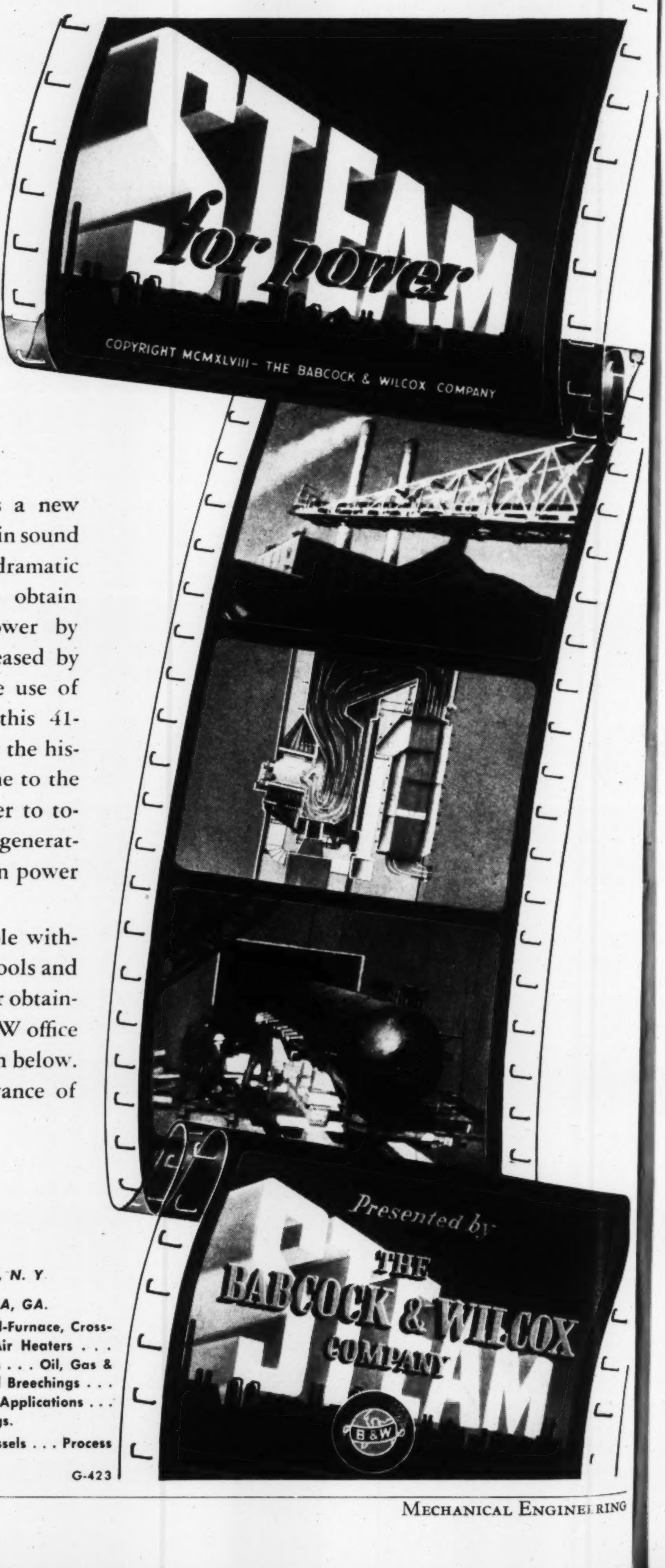
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MECHANICAL ENGINEERING

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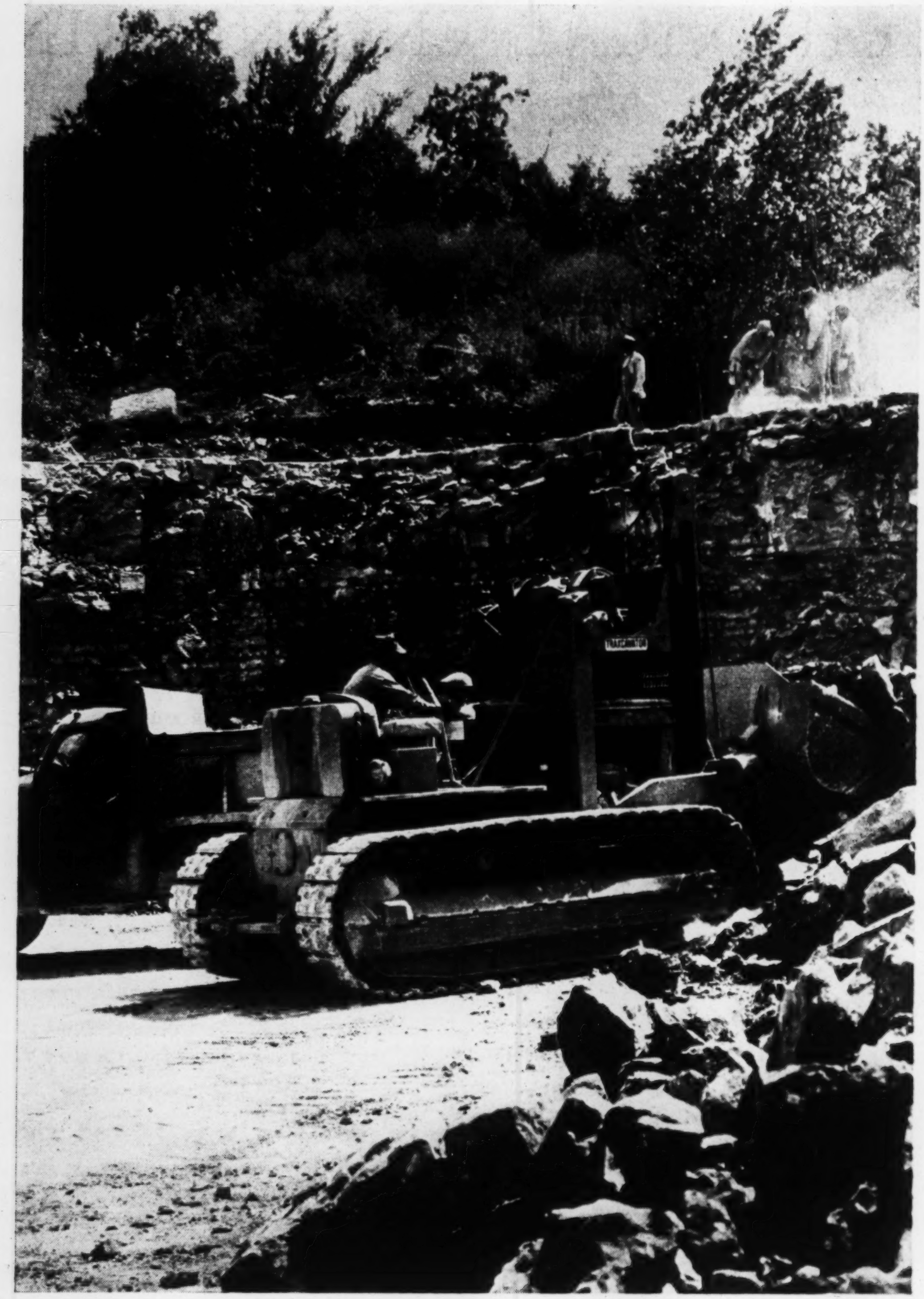

Tractor Excavator Loading Quarry Rock

(This machine handles 160 tons per hour, 20 hours per day with a fuel consumption of less than 3 gal of fuel per hour. See page 139 of this issue.)

VOLUME 71
No. 2

MECHANICAL ENGINEERING

FEBRUARY
1949

GEORGE A. STETSON, *Editor*

American Birthdays

THE month of February is rich in the anniversaries of men of significance to Americans and to engineers. The names of Washington and Lincoln are associated with crises in the history of the Nation of such importance that the twenty second and the twelfth have long been celebrated as holidays. On both of these anniversaries the great central theme is to be found in the historic words, "life, liberty, and the pursuit of happiness" which epitomizes the principles upon which our forefathers instituted a government of free peoples. They attempted to guarantee to every citizen certain "inalienable rights" and to open for each the doors of opportunity. In the minds of the persons who lived in those times of crisis there was something vital and precious in the principles and the way of life that was made possible because of them. A ferment in the social and political institutions of the western world was at work in the favorable environment afforded it in the New World. Courage, fortitude, and hard work could reap rich rewards when freed of the hindrances and frustrations imposed by the rigid and traditional social, economic, and political conditions prevailing in the Old World. A great experiment in human affairs was in progress. People had faith in its objectives, its method, and its ultimate success. They had assessed the costs and the risks as best they could. They had made the sacrifices. They were sufficiently close to the conditions they had changed to compare the new with the old. They were in a mood to defend what they had won at so great a price.

With the passing of the crises which threatened the principles upon which American democracy had been based, the Nation acquired a unity of purpose and ideals and an opportunity to pursue its destiny and to make the most of its industry and talents. The individual faced few restrictions on his initiative, his enterprise, and his ambition. Opportunities abounded in practically every field of endeavor. The demand for services was practically without limit. The rewards and satisfactions were abundant. In general, as an individual prospered the community and the nation prospered. Out of his ingenuity and industry new opportunities grew to demand the services of his fellow citizens. Progress was rapid. The standard of living climbed upward as the rate of productivity advanced and the amount of goods and services increased. The principles on which the Nation was founded, and as a result of which its social and economic institutions grew and prospered, were vindicated.

Typical of the flowering of individual enterprise, initiative, and ingenuity in the environment of the institutions made possible by adherence to the principles epitomized in Washington and Lincoln, although in an extraordinary sense, was the life of Thomas A. Edison, born on Feb. 11, 1847. A survey of his long and useful life raises the question as to how much of his success was the result of the social and economic environment in which he lived and worked. It was an environment which gave freest rein to his talents and placed a minimum of artificial restrictions on them. Ideas and inventions, like seeds, must be planted in fertile soil. They germinate, grow, and bear fruit only under favorable conditions. They may never take root. The plants may wither and die. They may be cut off or uprooted before they fulfill their promise. But the social and economic conditions under which Edison brought forth his inventions were as favorable for inventive genius as any which have ever existed. These conditions were his heritage and his good fortune, and they made his life and work effective and useful. It does not detract from his genius or from the glory of his achievements to remind ourselves that in this respect he was a child of his times. But he is also a symbol of his times, just as Washington and Lincoln are symbols of theirs. Give him personal credit for his extraordinary talents as is his due. But it is for us to remember the fundamental principles of social, economic, and political institutions which Washington and Lincoln symbolize and which made Edison's contributions to us possible and effective. Once we lose sight of those principles celebration of these February birthday anniversaries becomes a hollow tradition and a reproach to the generation which squandered its most cherished heritage.

American Way

THERE are few engineers whose lives and work have not been affected directly or indirectly by the genius of Edison. The list of Edison's achievements is long. His name will be forever connected with the incandescent electric lamp, and although many others share with him the honor of being pioneers in the era of electricity, we may, in this connection and without detracting from the credit that should be given to others, think of him as a symbol of their combined efforts. For it is our intention, by naming him on this occasion, to pay tribute to all of his kind and talents who provided the raw material of ideas upon which new industries are based, the old made more productive and efficient, the supply of jobs to engage the services of men and women in an industrial society made reasonably equal to the needs of the Nation, and our material welfare enhanced.

Such achievements are never the result of one man or of any group of men. They are possible only as they engage a maximum number of men and groups working together, each supplying some part without which the whole is impossible, incomplete, or ineffective. In the atmosphere of free enterprise and free institutions, industrial organizations, combining the essential skills of numerous specialists, have successfully developed ideas, inventions, and techniques essential for the maintenance of a high standard of living in a nation whose needs are enormous in number and variety.

When Edison handed the rough sketch of the phonograph to his colleague with the brief notation, "Make this," he set in motion that vast and complex machinery of industrial production which begins with an idea and ends in creating and satisfying mass markets. That machinery of production, in its figurative sense, has, as a tribute to its origin, been known as the American way. It has reached its highest degree of development not because of any superior qualities of our people but because of the favorable economic, social, and political environment in which our people have worked.

American know-how is eagerly sought by other nations. It is aiding in the restoration of their economies. But its full fruits will never be harvested in nations where men are not free or where social, economic, and political institutions impede its growth.

American Know-How

IN a little book, "The Challenge of American Know-How," written by Pearl Franklin Clark, wife of Wallace Clark, until his death in 1948 a Fellow of ASME, the weaknesses of Europe's industrial system are deftly portrayed in the author's description of the attempts of an American management engineer to introduce successful management principles in factories overseas.

When Wallace Clark went to Poland with the Kemmerer Mission in 1926 "to stabilize the zloty," Mrs. Clark was a normal American wife with a career—writing—of her own and with no more insight into the character and significance of her husband's work than the average wife possesses. She was too much engrossed in her own work to go with him for what appeared to be a few months in Warsaw, but when it developed that it might take a year to train a Polish staff to "Americanize" industry, she joined him abroad, taking with her a "play" to be rewritten. The year of work in Europe drew itself out into twenty; the play became less and less absorbing until it was completely forgotten; and when the Clarks left Paris just a couple of jumps ahead of the Nazis, Mrs. Clark was her husband's ablest colleague, and the playwriter had become an actor in the great drama of introducing American know-how into European industry.

The instinct and skill of the playwriter did not die when Mrs. Clark switched from drama to industrial reports, as her little book shows. Her story is a moving and personal one which records the growth of her understanding of what American know-how meant in European industries and to European industrial workers.

The great virtue of Mrs. Clark's book is that in it she records this growth of her comprehension of the challenge of American democracy and American know-how in simple language that any layman can understand. This challenge she sees both in its technical and its larger significance.

"If it is only technical know-how," she writes, "there is danger to all people. For the more we improve our technologies, the more devastatingly they can be used in selfish hands for selfish ends, and the more fear, insecurity, and want will follow.

"If it is the *American* know-how that we share—the democratic know-how that has been developing with increasing clarity and effectiveness in our factories, the danger is to dictators.

"For if we teach methods of work which liquidate peoples' fears but not people themselves; which encourage people to think and act freely, to remove their own obstacles and to develop their own resources, we are providing the know-how for freedom, security, and abundance in all the world."

Of Wallace Clark no physical picture is given—just a quiet, efficient, and forceful philosophy expressed in simple language. "Remove all obstacles to a free flow of work." "From the bottom up, not from the top down." "Consider nothing as static or unchangeable and nothing as impossible." And Gantt's expression of it: "Set down all you know. Improve it as much as you can. Teach it to others. Then go and find new, better ways."

The depression and the second world war raised questions in Mrs. Clark's mind, and when she returned to America she found "old-world" ideas and methods. Wallace had told her that she would find them. "I don't care if I do," she replied. "It isn't American."

At the end her faith in the American know-how is stronger than ever, clarified and purified by the bitter setbacks of depression, war, and the deterioration of the products of European factories Wallace had helped which began when the old-world methods were restored. It has been her role to sense and give expression to the spirit of the work Wallace and his colleagues did and the methods they used. Perhaps they would not comprehend just what she has found in the spirit of the American know-how. Certainly they would have expressed it differently. But she has sensed it and she has given it expression so that laymen may find in that work its more profound significance. "So I go on hearing about the American methods, watching them as I did in Poland and other countries, noting how they are used to remove obstacles to a free flow of work; that most of the obstacles are in peoples' minds; and how such minds may be kept from interfering with their own objectives and their own best interests.

"I go on seeing that methods do not work of themselves. There is often a long, heartbreaking period before people take hold and make them their own. Then, and only then, are they 'introduced into the life.' "

ROY V. WRIGHT—AN APPRECIATION

His Significant Contribution to Good Citizenship

By ALLAN R. CULLIMORE

FORMER PRESIDENT, NEWARK COLLEGE OF ENGINEERING, NEWARK, N. J. MEMBER ASME

SO often it happens that man makes a significant contribution to the welfare of society somewhat apart from his chosen vocation. While engineers are not prone to extend their influence into fields primarily involving morals, ethics, and politics, occasionally a man appears, perhaps two or three times in a generation, who does make a definite imprint in the fields of politics or government and accomplishes perhaps more for society in general than can be properly appraised until after his passing.

This generalization might serve as an introduction to an attempt to appraise the work of Dr. Roy V. Wright in the field of what we might properly call politics, government, or citizenship. Having been associated with him very closely in this work for a period of fifteen years, it becomes not only a privilege, but a duty for me to try to reflect something of the work which Dr. Wright has accomplished in terms which would be understandable to an engineer.

Contributions such as his are not easily explained. It would be necessary, perhaps, to search into his background for several generations in order properly to interpret and explain just why he felt that his work in this field was a thing which "must be done." I think it has never been my privilege to meet a man who was so carried away by an idea seemingly quite apart from his academic training and his professional experience. Very early in his career he evidenced a most uncommon interest in youth and its problems. He was identified very early with such movements as the Boys' Brigade, which preceded the Scout movement, in YMCA work on all levels; and in the future of the younger members of the ASME, of which body he was president in the year 1931. He carried this interest to all levels and in connection with all his activities. As a Sunday-school superintendent, and as a teacher, and as a lecturer, as I saw him in his later years, he considered it to be his duty—and I think the word "mission" could be used advisedly—in life, to bring to the attention of young people, particularly young people in his own profession, their duty with respect to community and country and their responsibility with respect to the functioning of government.

It is a little hard to exaggerate his singleness of purpose, his enthusiasm, and his tenacity in pursuing this endeavor. I marveled often, through the years when this work was new and when the experiences were not altogether pleasant—when some of the experiences had even a bitter tinge—how almost it seemed that much of this work which he felt so important sprang from something quite beyond the conscious. It could not be downed. It was foremost in his mind, no matter what his present activity.

Dr. Wright's contributions to engineering as an engineer are too well known for me to chronicle them here. His work in the railroad field and later as a publisher in New York, his contributions to his profession through the medium of the presidency of The American Society of Mechanical Engineers, are well known. I think it would hardly be saying too much to say that he will be remembered by more of the younger men—that is, the potential mechanical engineers—than any man that I have been privileged to meet. In all these several activities, too numerous to mention, this thread—or perhaps it would be better to say this strong cord—is woven through the fabric: this desire on his part to impress the youth of the land with their duties and responsibilities respecting their government.

When I met him first, a few years after his presidency of the ASME—a meeting which took place on a train coming from the Century of Progress Exposition of 1933 to Newark—he spoke at great length and with great enthusiasm and determination of his desire to help to impress young men with their responsibilities. He spoke, as I remember, particularly of his experiences as president of the Society, when he deemed it to be his duty to visit, perhaps more than had then been the custom, local sections and student branches of the Society scattered over the United States. I remember he spoke particularly of the insensitivity, apathy, and lack of interest of students, professors, and administrators alike—particularly of course in our engineering schools which he visited—toward matters which had to do with the individual's participation in government affairs at any level.

It so happened that at that time I had done a little thinking along the same line, and before the train ride was over I offered him a proving ground for his material, and we definitely planned a course of lectures to be given at the Newark College of Engineering which would give Dr. Wright a chance to organize, develop, and present his material. The courses, as I remember it, were instituted the following year and were continued until his death this year.

In connection with this, in 1933 President Potter appointed me chairman of a committee of the Society on a Manual on Citizenship, and Dr. Wright and I jointly engaged in the preparation and distribution of this material. It gave us a chance to work together and him to formulate his thoughts and present them to a considerable audience. I think that something over six thousand copies of this report were printed and distributed.

As time went on, Dr. Wright's influence was felt in connection with so many enterprises which had primarily to do with interesting young people in citizenship, that it would be hardly fruitful to try to enumerate them. He traveled from coast to coast speaking to all sorts of gatherings of engineers and others, always as earnest, as enthusiastic, and as forceful as he was at the beginning of the project. I marveled at the time he managed to give to this activity and to the unabated force he evidenced in pursuing it. Coupled with this, I think I never

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Roy V. Wright, past-president and Honorary Member, The American Society of Mechanical Engineers, died July 9, 1948.—EDITOR.

saw a man who was as dissatisfied in his own mind with the results. Time after time in discussing the matter he expressed a desire for some appraisal of the value of the work he was doing He never felt that he was accomplishing much. Those of us who saw the thing in a little more perspective and saw its effect as evidenced from year to year told him on every occasion something of the values which his work possessed, but always the query came back, "How can I tell, how do we know, how does anybody know, if this thing is doing any real good?" But strangely enough, this feeling that evidence should be available did not deter or in any way hinder or hamper his efforts.

In later years, when his political work took a great deal of the time which he had managed to take from his professional activities (for he carried successively the political positions of Freeholder and Chairman of the Road and Bridge Committee in the County of Essex from 1935 to 1937, and State Senator from 1942 on, serving at the same time on the Republican State Committee), the burden must have been excessive, but there was never the slightest faltering, no matter how heavy the load, and there was always time to think about and discuss matters which had to do with the duty and the privilege of the young engineer in the political field. It was to me a startling example of the persistency and the industry of a man in a field where the personal rewards were absolutely nil. It was the best example I have ever seen in our modern times of a man driven by a force and a conscience which brooked no interference and no delay.

LACK OF INTEREST

Perhaps some of the fundamental philosophy held by Dr. Wright and pursued by him would be of interest. I say, "perhaps" it might be of interest, and I might add that this lack of interest is the one thing which gave this man real concern in relation to his work. I think it is perfectly safe to say, after studying the situation with Dr. Wright for fifteen years, that this ***should*** have given him concern, and should give all of us concern, and it is my hope, in presenting this matter, that one or two, at least, will have the judgment and good sense to take up the torch where it fell and to help to advance Dr. Wright's thoughts and philosophy as they must be advanced if his work is to be developed to the point where it finally becomes effective in our governmental machinery. In fact, I have come to feel myself that this thing is terribly important, using the word perhaps in the most direct sense, and that unless its importance is realized, we are in for a time in this country which can properly be called "terrible" with any meaning that the word might carry.

First, Dr. Wright believed thoroughly that this subject was not an academic one and could not be studied and developed from an easy chair or from behind a professorial desk. His feeling in this regard was not only realistic, but sound in the extreme. He held that to advance into politics toward the higher levels, one must begin at the bottom. There seemed no way to introduce oneself at an intermediate level with any degree of success. While Dr. Wright assumed that engineers were doing a great deal in the political scheme, I think he felt that they were doing it, in the main, in a strictly limited professional way at technical levels, and not at the stage where over-all planning came into the picture. To put it into another and perhaps more understandable way, he felt that the engineer's work in government was largely the work of a hired man, and not of a policy-making man. While he found engineers attached necessarily to different bureaus of the government as technicians and as advisers, he found, as we find today, very few there on the fundamental policy-making level. A great many engineers are asked to carry out projects and implement them technically after the nature and purpose of the project have been developed and passed upon by politicians who were sometimes incompetent to judge of the general public interest.

I remember specifically that in one case we were talking about some expenditure which had fallen into the discard before the Bureau of the Budget and in which both of us were very much interested and which to us, as engineers, seemed very much in the public interest. It was during the war, when the necessity not only seemed great, but vital, and we tried to find someone in the Congress of the United States who might take an active part in presenting our view to that Congress and perhaps to the Appropriations Committee. At that particular time we found no one on the Appropriations Committee who had the slightest sensitivity to engineering or to the type of problem which this project seemed to involve. There was no one in the Senate. There was one man only in the House of Representatives who had had a few weeks' experience in a railroad surveying job. In this particular situation we needed only one man, simply someone to stand up and present some frontal attack with some background and some knowledge of the thing he was talking about, and no one was available.

I remember another occasion during Hoover's administration when Dr. Wright indicated that we had one engineer in Washington but one wasn't enough; that if we had five Hoovers there, much could be done; and if we had a hundred, the problem would be largely solved. I think personally that if a hundred men were in key positions in Washington—a hundred men trained, perhaps, or, more important, experienced, in some of the problems which involved professional engineering—we would have gone far toward the solution; and if those positions could be maintained over a period of time, the problem would certainly be solved.

FROM THE GROUND UP

Dr. Wright took definite issue with those who believed that engineers should stick to their profession or trade and not attempt to engage in some of the broader activities of politics. Basically his conception was that we must go up, in this political scene of ours, in this modern democracy, from bottom to top, and that at every level the engineer must be present and do his share of the work, no matter how simple or how onerous it was at the lower level.

The book which Dr. Wright wrote in collaboration with his wife, "How to Be a Responsible Citizen," reflected this thought as basic. The work to be done first was the beginning work. There must be work at the bottom. Certainly an engineer should understand this—a man who has to advance logically from the known to the unknown, from the simple to the more complex, from problems of minor importance to problems of major importance. He must be prepared to take his place in the government of the country, and he must begin that preparation early. He must know practically and firsthand what is involved—the type of problems, the type of solutions the type of people you meet—all the many factors and conditions which surround the effective operation of our political machinery.

Dr. Wright differed primarily with some of those who thought and preached in this field, by being willing to try to see how these things worked out and how his theories fared with the rough and tumble of the political world. In all this work, which he took so seriously and to which he devoted so much time and energy, the help and stimulation of his wife was of the greatest value. Sometimes politics becomes a matter not only of logic but of intuition as well, and in appraising the work of Dr. Wright, those of us who knew the situation best found constantly reflected, and in a larger measure as time went on, the influence and help, the intuition and good political sense, of Mrs. Wright. It was a most fortuitous combination —a combination which, as was expressed in the opening sentence of this paragraph, resulted in a realism, a practicality, and a desire to grip at firsthand the facts of the case which is very often lost sight of in those of us in purely academic fields.

Perhaps the problem was a bit harder, perhaps the amount of energy required was greater, simply because there was no compromise on the part of either of the Wrights with facts. They were faced squarely and courageously. They promised to the young actor in the political arena at first only hard work and only meager results—perhaps, from his standpoint, only infinitesimal results, for they dealt with such things as responsibility and duty and other things which sometimes at a tender age are not fully appreciated. The work was of course very much more effective from this standpoint, but it was harder. There was no sugar coating on the pill.

I think if we could put the idea into perhaps a single sentence, we might say that Dr. Wright's belief was that you could afford to shoot hard if you shot straight. I sometimes wondered if perhaps we did not lose a little by not trying to make the material more palatable, but on analysis, it seemed to me that perhaps I was only fearful concerning applause or approbation, and I don't think it made the slightest bit of difference to Dr. Wright what people thought of this as long as he could secure results. So it is perfectly safe to say that not only was there in this man much of conscience, but with it, much of the Spartan as well.

REALISTIC APPROACH

Another thing which Dr. Wright considered as fundamental was that young people should understand something about organization and the workings of the political machine as a whole—the informal as well as the formal. His contact with practical politics and with practical politicians showed him primarily the function of the caucus of political leaders—or bosses, as we call them—and he believed very thoroughly that whether or not a young person embrace this sort of thing, it was fundamental that he know something about it.

Of course this point of view ties in very closely with his fundamental theme, that no one should advance to a higher position in politics without a thorough practice and a thorough appreciation of the fundamental organizational pattern and the fundamental difficulties to be encountered at all levels. This part of his philosophy seemed to be, so far as I can judge, almost unique, and it is one of the most important single phases of his whole philosophy with respect to citizenship. While he appreciated the value of education at all levels and was very active in the education of youth in citizenship at the secondary as well as the collegiate level, he felt that in spite of all the talk and of all the preachment, nothing could be done except by actual contact and by an actual sharing in the responsibilities of citizenship, first at the lower and then at progressively higher levels. This bit of philosophy he discussed often, pointing out how important it was—particularly when introducing young people into the political scene—to have them understand thoroughly not only the theory but some of the limitations which parctice puts on theory in the political field.

Not only did this, in his mind, insure advancement, on the part of those qualified. to the highest levels, but it kept a continuous supply of material feeding in from the lower to the higher levels as a matter of routine and as a matter of course. I think he felt that one of the great practical difficulties faced by those who lecture to young people about politics was that the theories so grandly expressed, the sentiments which were so lofty, were soon found to be very difficult to attain when a young person entered politics at the lowest level, and there immediately ensued a sense of futility and a sense of discouragement which soon overcame any of the theories which had been presented in the classroom or had been got by reading a book or literature of any kind.

It was to a very considerable extent this crucial level that he wished to pass, and it could be passed, in his opinion, only by a clear and realistic knowledge presented straight from the shoulder as to some of the difficulties, some of the problems, and some of the unpleasant circumstances necessarily connected with our political machine at its lowest level.

He recognized that the average young man—particularly the average young engineer—looked at himself, on account of his education and perhaps on account of his profession, as a rather superior sort of person—one who, if he were to enter politics, was to enter at a higher level. He realized the utter impracticability of this thesis and realized clearly that politics does not pick one or two able men from the top, but that political place must be won primarily by willingness to work and by experience in the field of politics. I think it was his opinion that ability would take care of itself, provided we could insure to youth a continuity of realistic experience in the political field, and he sought ever in his writings and lectures to impress this fact definitely upon young people.

Several of the ventures which sprang directly from his efforts were singularly successful. One in particalar, centering around a group active in East Orange called the Polity Club, made a distinct impression on the whole political life of that city. The willingness of these young people to fight the thing through from the bottom to the top to take the hard knocks and to take the bitter with the sweet without a sense of superiority and without looking down upon anyone, no matter how humble his background or experience, was a very good object lesson to many of us in what might be accomplished if this question of the engineer as a citizen were approached in a direct and realistic sort of way.

HE LIKED PEOPLE

One thing that characterized Dr. Wright's theories as well as his practical political experience was that he was essentially a democrat—using the word not in its narrow political sense, but in its broad sense (because he had of course allied himself with the Republican party). He was essentially a man who liked people and treated them, no matter how humble, as if they were his equals or superiors in the political field. He had much reason, perhaps, to place himself above the average ward politician, but he never did. He won his way, as he advised young people to do, on his merits.

One quotation from a memorial by the YMCA of the Oranges put it in this way: "He loved his fellow men. This was the touchstone of his life and the secret of his success and influence." He liked to be with people, liked to talk to people, liked to try to influence people in the right way, and his method was a very interesting combination of forceful dignity coupled with a definite charm of manner. He was hard to resist, and this appeal of the personality and of the intellect, coupled with his passionate appreciation of the absolute necessity of our interesting ourselves in our own fate, made him a very hard man to resist on the platform or in his political field.

Dr. Wright realized that it was not only necessary to talk to the young, but in order to make these lectures and these addresses effective, he must have something to point to in the nature of an example in the higher ranges of his professional field. Very early in the development of his work he sought out, not only on the national, but on the local and community level, those men who had some background in science or engineering, to use as examples for his work; and I think that one of the greatest problems he had and one of the things that bothered him most was the dearth of that particular type of material. While he had some men who had, for reasons of duty, introduced themselves into the political scheme at various levels, he found, as has already been expressed, that the political lives of such men, who had probably been known as reformers, were generally pretty short. A man might go into the political arena for a year or two, be completely disillusioned and embittered, and finally withdraw of his own volition or be forced to withdraw by circumstances with which he could not cope.

REFORMERS

This, I think, to Dr. Wright, was the fundamental weakness of our present system of the education of youth for citizenship. People went in as reformers. People went in to tear down before they were to build, and in tearing down, they sometimes lost the capacity or perhaps the opportunities to build, as many iconoclasts do. In breaking images they have done only a small part of the job. It is so much more difficult to build than to destroy. Therefore what he sought and what he could not find were any considerable number of people who were constructive, who were positive in their political approach; people who were interested per se in building up, in seeing something grow; not people who went in necessarily to right a great wrong and after having destroyed the bad would be unable to persist long enough to build up the good in its place.

We talked about this on many occasions, and it was, I think he felt, a very grave condition, because, again, we must bring out that the whole philosophy of the man envisioned an early interest, a constant endeavor, and a persistent one lasting over a considerable period of years. Perhaps he thought, "The reformer comes and goes. The professional politician goes on forever."

I remember his once saying that he thought that politicians, even in the best sense, were not at all afraid of reformers because they knew that after a while they would get sick and tired of reforming, find that they were accomplishing little, and would gradually go back to the place where they belonged and not bother further with the efforts of the faithful.

In this connection, he allied himself some years ago, in connection with his first political office, with the then Republican leader of Essex County, the present Chief Justice of the Supreme Court of New Jersey, and then Dean of the New York University School of Law, Arthur T. Vanderbilt. The effect of Dean Vanderbilt's philosophy on Dr. Wright was very considerable, and it was interesting to note that in the later years he and the present Chief Justice worked hand in hand along lines to properly interest young people in politics as a career, as a continuous long-term effort. I think that this combination of two minds—better, of three minds, including Mrs. Wright—has had more effect in this metropolitan area than any other project conceived for the same general purpose.

But lastly, and most important, perhaps, of all, were Dr. Wright's theories concerning the moral and the ethical side of politics, and what I have to say about the moral and the ethical applies not only to politics on the higher level, such as state and national, but politics in the ward, the county, and the town. His belief—and his life and efforts proved his point—perhaps might be stated something like this: that when one entered politics, morals did not have to be sacrificed and that the applied mechanics of morals which we know as ethics—that is, the practical technology of morals—was something which according to the political code was sacrificed, ***but not of necessity.*** Stated perhaps in a little more popular way, he believed that present-day politics had a code of ethics—definite, perhaps, and in the main not to be considered as the highest possible code—but that a man entering politics had a choice as to whether he should be governed by this code or by his own. In other words, most of the people who entered the game of politics felt that they must play according to certain rules laid down by what they considered political leaders. But the truth of the matter was that such rules were only for the protection of the weaker members, and that the forthright man of straightforward uncompromising principles and a sensitivity to ethical circumstances could maintain these principles if he would. In other words, it seemed to him that so often a man getting into politics felt that he must of necessity become what is known in the improper sense as a politician; that he could not, for some strange reason, maintain his own integrity and his own code of ethics; he must assume those which the game required. Boiled down to its last analysis, this meant that a man entering politics was always playing the other fellow's game according to the other fellow's rules, which I think Dr. Wright believed was a fatal mistake. He stood foursquare in this regard, and in so far as my knowledge goes, never deviated from it in any one particular instance.

COMPOSING DIFFERENCES

I do not mean that he was an independent, as we sometimes use the word. He was not, in the improper sense. He had a mind of his own. He could be persistent, and even stubborn when he felt that a moral issue was involved. In some cases I have seen him oppose all sides on an issue of this kind, which involved an infinite amount of misunderstanding and sometimes abuse, but he always stood his ground and refused to abide by rules which he neither understood nor concurred in. As I have said, this should not be construed to mean that Dr. Wright might be called an independent in politics. I don't think he was. He was particularly interested in that most practical of all sides of politics, the composing of human differences. He realized that this was the essence of political success in any field and with any problem. He felt, I think, very strongly that the composing of human differences was one of the most important things that an engineer could do, whether it was differences between counties in a state government or differences between employer and employee in an industrial relationship. He realized that perhaps an engineer was ill-fitted to compose human differences. The engineer perhaps believes that compromise is a point of weakness, but with Dr. Wright, in the practical political field, it was a point of strength and vital importance, just as every engineering structure with which he was familiar on a railroad was a compromise between strength and stability and cost.

He wrote, I remember, an article having some such title as, "Is the Engineer a Lone Wolf?"[1] wherein he pointed out the absolute necessity of discussion, perhaps of argument, and certainly of the composition of those differences which were forever arising in connection with the political scene. His theory was and his practice was that such differences could be composed without recourse to either dishonesty or double dealing. He would have said, with Emerson, "The devil is an ass"—which, freely translated, might mean, "A man who isn't smart enough to see his way out by fair means finds a lie the only recourse." So many times he had, as we have, seen men lie because they had not either the intellectual capacity or the imagination to see that the truth was always the best argument. He felt it was and practiced it. I think as far as his influence on youth was concerned, this was one of the strongest points.

This attempt to develop in some way the thoughts that animated the contributions of Dr. Roy V. Wright may seem to have little logical sequence or coherence, but the thoughts have been set down by one who is deeply conscious of their worth, of their fundamental value, and also of the fact that they must be pursued if our democracy is to continue to function.

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[1] MECHANICAL ENGINEERING, vol. 68, August, 1946, pp. 717–719.

MULTIPLE-PURPOSE RIVER VALLEY DEVELOPMENT[1]

Progress Being Made in World-Wide Movement

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THE members of the Engineering Profession assembled for the 2nd World Engineering Conference—together with all other human beings on this planet—are living through a great historical tragedy. Ours is a time of wars of unprecedented violence, of waste and destruction beyond anything imagined by those who lived before us. Individuals feel increasingly helpless before the swelling tide of devastation. Politicians, statesmen, scientists, artists, the ordinary man-in-the-street or on the farm, and of course, engineers—all are infected with foreboding and pessimism.

The tragedy of this historic period has washed not only over the world's men and women but onto the earth from which they draw their sustenance.[2] A combination of erosion of the life-sustaining soil and floods, of predatory mining, grazing, lumbering, farming, and industrial practices, and of traditional prejudices and recurrent wars, has piled destruction on destruction until a rapidly growing world population must soberly contemplate a climax of starvation, want, and death. Many facts bear out the story of wastage of the earth; others reveal the participation of every mortal in the tragedy.

Yet, oppressive and melancholy as all these facts are, they reveal only half the story, the dark side of our time. The record of a 24-hour day is not only the story of night. It is also the story of the light—the half of the day when humans work and plants lift their heads. Less, perhaps, than any other group, can we engineers afford to live only in the atmosphere of tragic night, for in our hands are tools and techniques which can create a more abundant life and make glowing hope a part of the story of man's contemporary day.

Joined with the work of those who are in politics, the arts, sciences, and social relations, engineers can help to thrust the world forward, out of this darkness born of man-made devastation, and into the brightness of a reconstructed earth which will give an ever-increasing return to human beings. This inherent strength and power are already emerging in parts of the world.

TENNESSEE RIVER VALLEY DEVELOPMENT

A notable example is in the valley of the Tennessee River, ranging with its tributaries through seven states and parts of states in the southeastern section of the United States. Here the Tennessee Valley Authority (TVA) was set up in 1933, designed to develop in harmony, each with the other, all the existing and "creatable"[3] resources of the 40,000 square miles included in its watershed. TVA has already advanced the arts and sciences of conservation in scores of ways. But even so, it has only begun to point the way to ultimate goals. Other significant developments in conservation techniques—not inspired by TVA—have been inaugurated in recent months in other parts of the United States, and doubtless in other parts of the world. This multiheaded drive gives us confidence.

The TVA idea involves drastic decentralization and recognition of the watershed as a logical area for public administration, especially where the conservation and most effective use of soil and water are first considerations. To provide for the maximum of self-containment and flexibility in the exercise of its delegated authority, the TVA was given a corporate form somewhat like that of a private business enterprise. TVA is quite independent of the old-line centralized agencies of the federal government, and reports directly to the President and the Congress. Its own Act covers completely the policies under which it must function. As need has arisen, this legislative code has been amended to meet new conditions.

The Authority was directed specifically to foster river navigation and to minimize floods on the Tennessee River, and to prevent high water on the Tennessee from adding to flood heights on the Ohio and lower Mississippi, to build such multipurpose dams as might be required as well as the transmission lines necessary for marketing the resulting hydroelectricity.

Soil and water are major strands in the life of valley people the world over. TVA's assignment of necessity carried with it the responsibility for the development and utilization of all natural resources. In the long run then, by implication if not by statute, TVA was given responsibility for fostering and developing education, health, welfare, and cultural activities which are the prerequisites for improved standards of living. As a high level of living requires an increasing industrialization with a corresponding decrease in the number of agricultural workers,[4] the sound development of industry—both of industries already established and those to be established—is another important facet in TVA's assignment.

The TVA Act called for no exploitation of the easy and obvious but rather an effort to build from the ground up, on technically sound foundations, a structure of rapidly expanding scope and utility. And it must be constantly emphasized that the beneficiaries of this development were to be people—men, women, and children of the Valley. TVA has at every turn found it feasible to safeguard and even to advance private interests, both those already in existence and those new to the Valley, that found there an environment favorable to private as it has been to public enterprise.

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[1] To be presented at the 2nd World Engineering Conference in Cairo, Egypt, March 20–26, 1949.

[2] "Our Plundered Planet," by Fairfield Osborne, Little-Brown & Company, Boston, Mass., 1948, 217 pp.
"Road to Survival," by William Vogt, William Sloane Associates, New York, N. Y., 1948, 288 pp.

[3] This word is not in the dictionary but should be.

[4] "Some Observations on World Industrialization," by Morris L. Cooke, presented at the First World Engineering Conference, Paris, France, 1946; reprinted in MECHANICAL ENGINEERING, vol. 68, 1946, pp. 406–410, and *Congressional Record*, June 18, 1946.

FUTURE VALLEY AUTHORITIES

While future valley authorities, to be established in the United States and elsewhere throughout the world, may be expected to correspond broadly to TVA, there should be no attempt at duplication. Valleys will never be replicas of each other, and so the relative importance of different types of accomplishments will vary from project to project. Under one valley authority, hydroelectric development may be the outstanding achievement; in another, spectacular changes in agricultural methods may result; while elsewhere a diversified industry may more or less completely change the way of community life. Only in over-all objective will they be identical—to develop to the full, and in complementary fashion, every resource of the watershed for the benefit of its entire population.

Studies made in the United States Department of State during World War II indicate that among the potential sources of energy, hydroelectric—the form in which watershed development is specially interested—ranks first in most of the world. Present output in kilowatthours is only 4.3 per cent of that potentially available for development. These resources are greatest, and yet least utilized, in the less-developed areas of the world, as shown in Table 1.

TABLE 1 POTENTIAL HYDROELECTRIC RESOURCES

	Per cent of world's total hydroelectric energy supply by regions	Percentage of regional total now being utilized
North America	9.2	19.7
Middle America	2.4	1.9
South America	11.3	0.7
Europe	9.2	17.7
USSR	11.8	1.5
Africa	41.0	Negligible
Asia	14.2	4.1
Oceania	0.9	4.6
	100.0	

In plans for industrialization, especially in areas with a high percentage of agricultural workers, ways must be found for shifting agricultural workers to occupations in industry. Furthermore, an effort must be made to bring archaic agricultural techniques up to the best modern level, so that a reduced number of agricultural workers can provide adequate quantities of food and fiber for the population. Agriculture itself should be industrialized by the creation of local plants to process agricultural products.

Small and middle-sized power plants and their associated factories have a purpose as pilot installations—models for numerous others—especially in such large and industrially undeveloped areas as India and China. Some idea of the possible lines which might be followed in developing small-scale industries can be formed from the United Nations Relief and Rehabilitation Administration project undertaken in China under the direction of Harry G. Clements. This project utilized local resources and labor to produce items particularly needed in undeveloped, rural areas. Plants were constructed fore the production of cement (output 50 to 100 bags a day), coke (50 tons a day), tar (2600 gallons a week), sulphuric acid (62 gallons a day), organic fertilizer (5 tons a day), iron castings (1200 pounds a day), and milled rice (3 tons a day).

River valley developments have a deep significance in that they tend to establish, and gradually extend, soil-erosion control. They foster, for instance, recognition of the importance of upstream engineering[5] and development of a modernized tillage system on the land itself through contour plowing, strip farming, terracing, mulching, and a thousand and one other helpful measures.

No arguments for soil-erosion control can speak more loudly than the millions on millions of acres on every continent which already lie ruined for the use of man. On the tomb of one civilization after another might well be inscribed, "In memory of a once prosperous people which perished because it failed to safeguard its soil—the source of all life."

Over 60 years ago Shaler, a geologist and distinguished American citizen, said:

"It is a question whether human culture which rests on the use of the soil can devise and enforce ways of dealing with the earth which will preserve this source of life so that it may support the men of the ages to come."

There are hopeful signs that this generation is stirring itself to deal with its earth. The following high lights of developmental activity give grounds for optimism:

FIELDS OF ACTIVITY

Brazil. In the matter of both land tenure and population, the valley of Brazil's San Francisco River contrasts sharply with the Orient. Land in the San Francisco Valley normally is held in large blocks under something approaching squatter sovereignty, and the population is exceedingly thin compared with that which might be supported under multiple-purpose river development.

The Paulo Afonso Falls on the San Francisco afford one of the greatest hydroelectric power sites in the world. Its potentiality is heightened by the fact that there is a ready market for most of the first block of power to be made available. Here electricity will supplant oil and wood-burning plants inconvenient to operate.

The Brazilian people, impressed with the feasibility of a San Francisco Valley Authority, provided for one in their recently adopted Federal Constitution, even to the point of fixing the percentage of the total national revenue to be devoted to engineering developments. World War II proved the value of this 1700-mile-long waterway when it was used to bring out thousands of tons of minerals in scarce supply.

China. Unlike the San Francisco Valley, land in China is predominantly held in densely populated areas in small plots with titles difficult to challenge. Under the improved living associated with integrated valley development, death rates go down. If the birth rate does not drop correspondingly there may occur what Eugene Staley calls a "population explosion."[6] In the Far East appropriate educational efforts of a wide variety are quite as necessary as dam-building and suchlike.

The most immediately desirable scheme for China calls for hundreds of relatively small river valley developments. They should have hydroelectric plants located upon the upper reaches of the main streams, appropriately sized factories, widespread soil-conservation practices, and irrigation where needed. With China's lack of transportation facilities, plants mainly using locally obtained raw materials and manufacturing products in ready demand in local markets afford the surest route to an ultimate and widespread industrialization. Favorable sites for such developments abound in China. One outstanding American industrial organization, having had long and profitable business associations in China, out of something akin to gratitude, has considered the promotion of one such installation to prove to the Government its social and economic advantages. For the moment, however, the Central Government does not appear to exert sufficient control in the back country to warrant such projects.

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[5] See "Headwaters Control and Use," proceedings Upstream Engineering Conference held in Washington, D. C., September 22 and 23, 1936, Government Printing Office, April, 1937; and "Little Waters—A Study of Headwater Streams and Other Little Waters, Their Use and Relations to the Land," by Harlow S. Person, Government Printing Office, April, 1936. A recent Spanish translation of the latter is available through the U. S. Department of State.

[6] See "Some Problems on Economic Development in the Orient," by Eugene Staley at Princeton University Bi-Centennial Conference on the Development of International Society, October 11, 1946.

French West Africa. A highly successful project beginning with a diversion dam at Sague on the Niger River in French West Africa (700 miles inland from the Atlantic Ocean),[7] conveys water for 25 miles in a dead river bed between the main stream and communities with a population of 25 000-30.000 cultivating cotton and rice. Whereas in most valley schemes power is a feature—sometimes the controlling factor—there is no power generated on this project. The difficulty of obtaining generating machinery in the period just before World War II and since, largely accounts for this omission. Diesel engines do provide electric light for the villages.

From the beginning, consideration for the welfare of the workers has been evidenced by enlightened provisions for housing, education, and medical care. A considerable measure of co-operative ownership and management has been combined with full opportunity for individual initiative to make maximum production possible. When the postwar shortage of the needed raw materials and heavy machinery is met this project promises to become a model of what remote colonial administration can be.[8] Adequate pondage on, or adjacent to, the main stream is planned to produce firm power, control floods, and regularize navigation.

The British point out that while the most effective river valley development demands a single authority and one overall plan, the French being "up river" were led under wartime compulsion to take the water needed for their enterprise without consultation with the authorities in British West Africa through which the Niger later wends its all but useless way.

India. Detailed plans for a Damodar Valley Corporation in India have been made by British and Indian engineers with the participation of William L. Voorduin, formerly of the TVA. This river, which flows through the Provinces of Bihar and Bengal, has a small drainage area as compared with other rivers in India. Nevertheless, during flood periods, it frequently has caused much destruction of property, serious interference with vital communications, and grave loss of life. The Indian Government feels that its projected multipurpose treatment of the river and its watershed for forestry, agriculture, fish culture, irrigation, drainage, industrial and domestic water supply, navigation, flood control, power and industry will act as a beacon—showing just how the objectives can be attained and whether the development can be made profitable in the widest sense. Perhaps greatest importance is attached to the DVC as a means of giving Indians confidence in their own capacity. The project is intended to serve as a school for all levels of operation, with emphasis not only in the technical training but also on the psychological, anthropological, sociological, and cultural features.

Pandit Nehru has taken a personal interest in the project.

Palestine. The plan of the Jordan Valley Authority is designed to solve Palestine's two chief economic needs; water for irrigation and power for industrial development. The sweet waters of the Upper Jordan and its tributaries will be diverted into a network of irrigation canals serving the adjoining lands. In order to compensate the Dead Sea for the loss of these waters, salt water will be introduced from the Mediterranean. Taken at a point near Haifa, the sea water will flow eastward through open canals and a short tunnel, down to the Jordan Valley and the Dead Sea. As this water will be dropped 1200 feet, a considerable quantity of hydroelectric power can be developed.

Failure to carry out this plan would be regrettable. The Authority would bring a marked rise in the level of living for Jew and Arab alike and give economic unity to the areas affected. The progress already made in improving agricultural methods, especially on lands normally held to be unavailable for growing crops, makes this Palestinian project specially inviting.

Scotland. From the wild mountainous country to the west of Loch Lomond in Scotland, about which Sir Walter Scott spun his intriguing yarns, comes word that the recently created North of Scotland Hydro-Electric Board has already begun dam construction on Loch Sloy. This project, part of a $400,000,000 power program authorized by Parliament, will increase Great Britain's electricity supply by one seventh and greatly ease the coal situation. The power will put electricity into the homes and on the farms of the Highlands; supply existing power enterprises that now develop electricity mainly from coal; encourage large-scale industry in the Highlands; and will feed power into the nation-wide British Electricity Grid.

For generations, Scotland has lost the pick of its young men and women to London, the Empire, and the United States. The new electric-power development may help stop this drain, although electricity of course is not all. The Scottish office in Edinburgh is conducting an intensive program of research to develop Scottish resources, by the improvement of forestry, agriculture, and fisheries, similar in many ways to the program of the TVA—and including the use of phosphates.

Mexico. In Mexico there has been an increasing interest in the possibilities of river valley development, especially during the current administration of President Aleman—who recently made a thorough inspection at TVA. A growing scarcity of water in the north, northwest, and central parts of Mexico is due in part to cutting down the forests and to poor agricultural methods. Two years ago, in the Federal District, there was a spectacular breakdown of the electrical supply due to low water in streams on which hydroelectric stations were located. The authorities, aroused to the need for immediate and long-range steps, recently established the Ministry of Hydroelectric Resources to take over-all charge of remedial measures.

In 1947 the MHR set up the Papaloapan Commission—the first of a proposed series of decentralized agencies, modeled a good deal after TVA—to plan and carry forward the over-all development of the Papaloapan River Basin. This area of 45,000 square kilometers, with 200.000 population, lies largely in a tropical region of heavy rainfall. The program includes erosion control, water storage, and power generation on the upper reaches, and drainage, and aids to navigation on the lower.

Puerto Rico. Puerto Rico affords an outstanding example of a rapidly falling death rate with an actual increase in the birth rate, resulting in too many people for available jobs. To help meet this situation an elaborate electricity scheme has been set up under the guidance of a distinguished Puerto Rican engineer, Antonio Lucchetti. This large increase in energy supply is opening the way for wider industrialization. Plants built recently produce cement, glass bottles, paper, cardboard, shoes, textiles, leather goods, and clay products, among other commodities.

The recently organized Water Resources Authority, which owns and manages all hydroelectric generation and distribution, has stressed multiple use of water resources for power development, irrigation, and water supply, and has directed attention to the importance of erosion control. The steep slopes of the interior of the island, the fierce tropical rainstorms, and centuries of bad farming practices have already robbed Puerto Rico of 25 per cent of its top soil.

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[7] See "The Niger Valley," by Maurice Claude Rossin, in *Survey Graphic,* January, 1945.

[8] The author of this paper will be glad to furnish on request a copy of a specially interesting letter dated Sept. 24, 1948, describing the present status of this project from M. Rossin, now in charge of the Office of Colonial Scientific Research in Paris.

The Puerto Rican Government has been planning consistently since 1915 to utilize, by means of storage, tunneling, and otherwise, the heavy rainfall on the north side of the island for the generation of electricity on the south side, where the mountain slopes are steeper and where the rainfall seldom exceeds 30 inches a year. This transfer of water from watersheds on the north side of the Insular Divide, where the average rainfall exceeds 80 inches a year, to the south side not only affords greater power heads for increasing the available energy, but also provides water for irrigation of the rich alluvial plains of the south coast. This arrangement does not preclude transmitting the energy thus generated back to the original watershed, which is more densely populated than the south side of the island.

SCIENCE AND ENGINEERING HAVE THE LEADING ROLE

Even such a casual look at the world-wide record shows that science and engineering have become the only basis on which really effective multiple-purpose watershed developments, and comparable conservation measures, can be successfully established. This is not as yet fully understood.

Until the comparatively recent arrival of a systematized and penetrating science with its empirical and vaulting colleague engineering, we witnessed the all but futile, and ultimately self-defeating, strivings of individuals against a nature they made little effort to comprehend. Over most of the earth both in agriculture and industry, witchcraft and a prehistoric series of occult influences have given place to "thumb rules," held to be dependably based on experience. This approach answered in a way the problems of a period when populations were small compared with those of the present day and when cultured living was thought to be feasible only for the few.

Present-day conditions demand something more advanced. Science and engineering really do constitute a large part of the answer. But engineers and scientists will do well to evaluate certain factors which seem to bar them from performing fully in the rapidly approaching world of tomorrow.

Both our individual and collective lives are inextricably woven into the life of what we call the community; into community life as it is experienced in ever-varying associations over progressively widening ranges—from the family through the various public and quasi-public organizations of city and state, up to and including the increasingly dominant international scene. At whatever point we examine this milieu, the closer and more harmonious the relationships the greater the yield in those material and moral values which make for continuously satisfactory living. Acquaintance leads to understanding if its underpinnings are goodwill.

The base frame supporting this widely ramifying complex called community, is comprised largely of those sectors involved in government—the agency engaged for the most part in doing the things which we cannot do for ourselves. The community rests on our system of laws, and on the personnel engaged in drafting them as well as in seeing to it that they are observed—legislators, clerks, cabinet officers, policemen, and others. Protection of the public health, the design and construction of public work, and a thousand and one other controversial and noncontroversial activities are involved. Of such is government constituted.

RESPONSIBILITY TO THE COMMUNITY

We engineers and scientists usually refer to all this with at least a shrug and frequently a sneer—as "politics." As a rule, professional groups are completely detached from government, except during war. The great majority of individual scientists and engineering practitioners are almost passionate in their desire to stand aloof. Such an attitude on the part of highly skilled technicians adds up to a near-fatal weakness for the day that we fondly hope is dawning for civilization. Our engineering profession has a day-to-day responsibility to the community and it must increasingly study ways and means for gradually placing itself in a more influential position with respect to government. Politics, it must be remembered, is just one name for those efforts, good or bad, by which individuals or groups persuade the community to undertake any kind of organized activity by means of government.

The political structure embraces the highest aspirations of the truly great, together with the venal plottings of those devoid of social vision. This structure is so related to the life of mankind that were it to be destroyed today it would by the irrefutable logic of necessity, be reconstituted tomorrow. Admitting the waywardness of politics as we may and must, we engineers cannot continue to stand aloof. In most of our lives community-minded citizenship must take precedence over professional status. The extent to which science and engineering meet the mounting threats to our collective well-being, even to our very existence, will be in direct relationship to our ability to live in relative peace and harmony—at least in sympathetic understanding—with our political agencies. We must learn to live with those political agencies through which the results of our labors are actually installed for the benefit of the people. In the atomic-fission field, experience proves that to secure the unprejudiced attention of government and politics in our capacity to serve is one problem. To learn the art of serving with appropriate humility may prove to be even more difficult. This means for our groups, "public relations" on the grand scale.

The engineers with the scientists—including the social scientists—have all the tools there are now. It is not more science or better engineering we need in the present emergency so much as the prompt application of what we have. But the will of the human race to authorize the application of present knowledge is politics—essentially community behavior. Some of this behavior is less commendable than the rest. But if we are to act greatly we must learn to live with it—the good with the bad. The chasm which now separates engineering and politics must first be bridged to meet current emergency conditions. Ultimately, the gap between engineering and the life of the people must be closed. Only so can engineering be made another manifestation of that Ultimate Reality to which the human spirit itself is kinsman.

A CAMPAIGN AGAINST THE FORCES OF DESTRUCTION

The limitless expansion of scientific knowledge, new levels of education for greater numbers of the people, communication all but instantaneous with the uttermost ends of the earth, schemes of world-wide co-operation between savants, vast increases of available capital, are among the more obvious influences that herald a continuance of the march of life on and upward from the amoeba to Einstein ($m = E/c^2$) and to the enthronement of Mind.[9]

Altogether we know a great deal about the techniques for improving conditions in the river valleys of the world. With populations mounting and the sources of our food supply dwindling, certainly multiple-purpose watershed developments open one immediately available and proved way whereby the physical sciences, the social sciences, and engineering can march together in a campaign against the forces of destruction.

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[9] See memoranda by W. I. Vernadsky (described by George A. Baitsell, editor of the *American Scientist*, as "one of the most remarkable scientific leaders of the present century"), translated by George Vernadsky and G. E. Hutchinson for the Transactions of the Conn. Academy of Arts and Sciences, June, 1944, and by George Vernadsky for the *American Scientist*, January, 1945.

CIRCULAR SAWS

Problems in the Design, Manufacture, and Operation of Standard Saws for All-Purpose Work

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THERE are at least four groups or individuals who are, or should be, interested in considering the factors affecting efficient and economical sawing practices. These are (1) the saw manufacturer, (2) the saw-machinery manufacturer, (3) the manufacturer of saw-maintenance tools and equipment, (4) and last, but by no means least, the customer or user of the foregoing tools and equipment.

The activities or interest of these groups can be placed into three divisions, i.e.: (1) design and manufacture of saw blades and machines, (2) operation of the machines and tools, (3) maintenance of the equipment and tools.

THE MACHINERY MANUFACTURER

Our first consideration is the function which the machinery manufacturer performs in the search for more economical and efficient sawing practices. As the customer demands more and more production at lower and lower costs per unit, the sawing-machinery manufacturer must produce equipment to meet these demands. The demand for higher arbor speeds, faster stock feed, and more accurate cuts must be met by machines which are better-designed, more accurately manufactured, and require the minimum in operation and maintenance costs. Since these machines are designed to be used for a number of years, it places the machinery manufacturer in the position of being a prophet who is expected to foresee what type machine will be needed two, three, five, ten, or more years in advance. Then, after he has looked into the crystal ball and determined upon his future creations, he must produce them accurately, without flaws or manufacturing "bugs," and be able to deliver them "yesterday." Here then, is the first definite need for co-ordination between the machinery manufacturer, the saw-blade manufacturer, and the user. No individual or group in these three classifications has all the answers, although there is no doubt that by working together a more satisfactory solution could be found.

Manufacturers of sawing machinery and equipment for this remanufacturing field, within the last few years, have shown more and more interest in aiding in the solution of the cutting problems which face the woodworking industry. Gone is the old attitude of "you've bought it, you can run it." Most firms in these fields are eager to help their customers in solving their cutting problems. Some manufacturers render this service on their own, while others co-operate with the saw-blade manufacturers and the users.

For many years there have been many users of saw blades who have felt that the saw-blade manufacturers have intentionally made a mystery of the specifications and principles which underlie the manufacture of circular-saw blades. From all the available evidence, there is none to substantiate this belief. Observation in many woodworking plants has indicated that there is more evidence to show a greater secrecy among the saw filers and maintenance men as to their methods than there is among the saw manufacturers.

The saw-blade manufacturer has but one motivating reason for producing saw blades—"to sell them." They can continue to sell them just as long as the saws meet the needs of the user and are designed and manufactured to fabricate efficiently the customer's product at a profit. Therefore, there can be no logical reason for not producing the best saws possible to meet the many needs of the woodworking industry. The saw manufacturers have set up certain standards in diameters, gages, and tooth spacings. Many users have questioned the wisdom of these more or less rigid standards, although the reasons for such standardization should be apparent to any group of production men. To manufacture off-standard or special sizes for every customer would throw the production schedule of any saw manufacturer into chaos. Without these standard saws, which successfully solve the great majority of all cutting problems, the price of all saws would be much higher. There are comparatively few specifications or manufacturing processes which are secret or exclusive among saw manufacturers. The few patents or exclusive processes which are recognized in the trade are for improvements on standard specifications. This paper is concerned primarily with the standard specifications which are generally accepted by the saw manufacturers and the users. The individual user or plant may have determined by trial-and-error methods that some special fitting or tooth shape will best fit his particular needs. These departures from standard, if not too great, are made by the plant-maintenance department or by some individualistic filer. There are many such plants and filers who have made valuable contributions to the woodworking industry.

NO MYSTERY IN SAW SPECIFICATIONS

The standard specifications which are usually written on the order for a circular saw are brief and leave much to be supplied by the saw manufacturer. There can be no doubt that this brevity contributes in no small part to the belief that there is considerable mystery in saw specifications. The usual order for circular saws will specify diameter, gage, number of teeth, type of tooth, arbor hole, and type of saw. The saw manufacturer would be very happy if he could get *that* much information. Other information and specifications which are filled in by the saw manufacturer when entering the order in the plant will refer to the type of steel required, heat-treatment, finish, front hook, back clearance, etc. These specifications are considered as being the responsibility of the manufacturer, with few minor exceptions they can be obtained from any saw manufacturer. The fact that there are many specifications on the final factory order will account for their elimination on the purchase order. The basic specifications, as related to wood-cutting saws will be explained briefly.

Steel. The greater percentage of wood-cutting saws are made of high-carbon steel with a range in carbon from 0.070 to 0.080 per cent. The other materials used are usually nickel, chrome,

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vanadium, molybdenum, tungsten, etc., for imparting added strength, resistance to wear, and ability to withstand shock and distortion.

The heat-treatment of the saw plates will vary with the several manufacturers, but most will fall within a Rockwell C range of 34–44. This variation will be closely related to the variation in the make of the steel. The hardness will also vary with the manner in which the teeth are to receive their clearance. A swaged-tooth ripsaw must be soft enough to work out in the swage without breaking or crumbling. The hardness of these saws usually runs 37–39 Rockwell C. A spring-set ripsaw can be harder, since the tooth is bent slightly. Hollow-ground saws are somewhat harder, and when customers have tried to set them the result often has been broken teeth.

Diameter. The diameter of any saw is limited or determined by the material to be cut, the design of the machine, or both. The diameter is usually listed in even inches. Some machines are so designed that the maximum diameters are odd. This fact often slows delivery, and limits the work the saw can do. Saw manufacturers and designers will do well to keep this fact in mind, for greater economies can be enjoyed, if this is heeded.

Plate Gage. The plate gage is an item which has been receiving much thought by both the saw manufacturer and the user. There are real and conservative reasons behind such consideration, i.e., conservation of steel and reduction of waste in the saw kerf. Changing the kerf from $^{3}/_{16}$ to $^{1}/_{8}$ in. represents a $33^{1}/_{3}$ per cent reduction in sawdust waste, Fig. 1. This represents a real saving to the user, and a distinct contribution to our wood-conservation program. A reduction in gage thickness brings its own problems for the saw manufacturers, the saw-machine manufacturer, the user, and his maintenance department. It is easily understood that more difficulties are involved in producing and operating a saw of 16 gage, as compared with a saw of the same diameter of 12 gage.

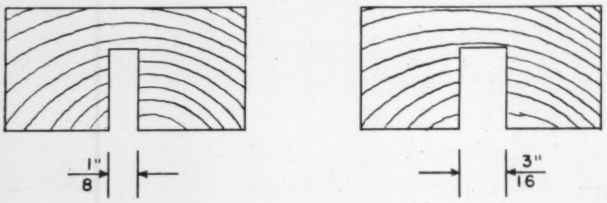


FIG. 1 A REDUCTION OF $^{1}/_{16}$ IN. IN KERF CAN REDUCE WASTE $33^{1}/_{3}$ PER CENT

The accurate manufacture of the saw blade itself is of course a matter of prime importance. The accuracy and operating condition of the saw machine is of equal importance. A slight runout of the arbor, collars out of true, improperly set fence or, in case of power-feed saws, poorly adjusted chains or track, all affect the efficient operation of the saw. Maintenance of the lighter-gage saw is also a problem. The tension must be checked more carefully and maintained. Sharpening requires extreme care to insure that all teeth are cutting in line. Unless all teeth are in line and in true circumference, the blade will tend to wander and vibrate, producing rough cuts. This also will create heating of the saw and eventually will result in cracks.

Number of Teeth. The number of teeth is an item which is being questioned by saw manufacturers, saw-machine builders, and users. In many cases, there have been no changes in the number of teeth since our ripsaw machines had a top speed of 1800 to 2000 rpm. With our present speeds of 3600 rpm and higher, it is apparent that this specification should be analyzed carefully. A saw-machine manufacturer, a sawmaker, and a large furniture manufacturer are co-ordinating their efforts to determine the most efficient arbor speeds, tooth spacing, fitting, and the like, for economical operation. These tests are being made with saws containing 8, 12, and 16 tungsten-carbide-tipped teeth on power-feed ripsaws, operating at an arbor speed of 7200 rpm. While these tests represent a somewhat radical departure in saw specifications and arbor speeds, such testing is necessary if progress is to be maintained. The results of the tests in their final form will be based upon the chip load per tooth per revolution of the saw. This chip load will of necessity take into consideration the type and condition of the material being cut. For example, this method is already used in the metalworking trades. However, in metal we have an entirely different type of material with which to work. A 1045 SAE steel is a material held to close manufacturing limits. Therefore, when tests indicate that 1-in. flat bar stock of this material can be cut efficiently at 15-in. feed, using an 8-in-diam slitting saw with 68 teeth, running at 30 rpm, most users can set their machines at those figures and expect satisfactory results.

Now, in all fairness to sawing-machine manufacturers, saw manufacturers, and users, is it possible to visualize the confusion and difficulty of establishing such a set of figures for such a material as red gum? Enumerating some of these problems: In modern sawing machines there is a single arbor speed, usually a direct motor drive; at most, there are four rates of feed selections; about four different tooth spacings are available in standard ripsaws; and finally, (and here is the big question mark) the many and varied conditions of this material to be cut due to various degrees of moisture content from soaking-wet to powder-dry, must be considered. It is apparent that any real solution in the matter of tooth spacing with definite chip-load recommendations for various materials is not yet available in tabulated form.

Hook. Over a long period of time the hook of the rip tooth has been set, at approximately 30 deg. A line drawn along the front face of the tooth, Fig. 2, is tangent to a circle (using the center point of the saw as a center), which is one half the diameter of the saw itself. This would be a 6-in. circle for a 12-in. saw. This hook is a matter which has, and no doubt always will, cause much discussion and difference of opinion. There is no doubt but that any differences of opinion are confined to a

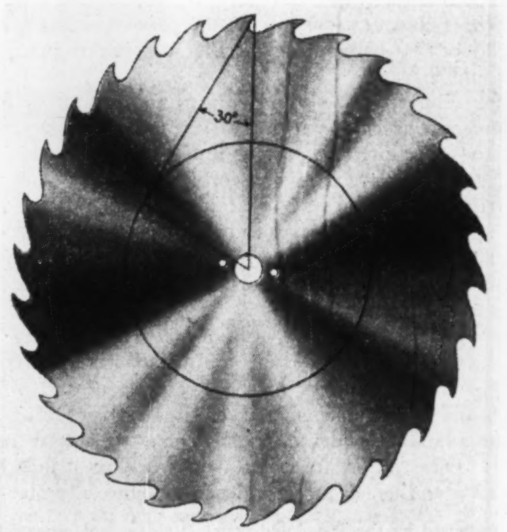
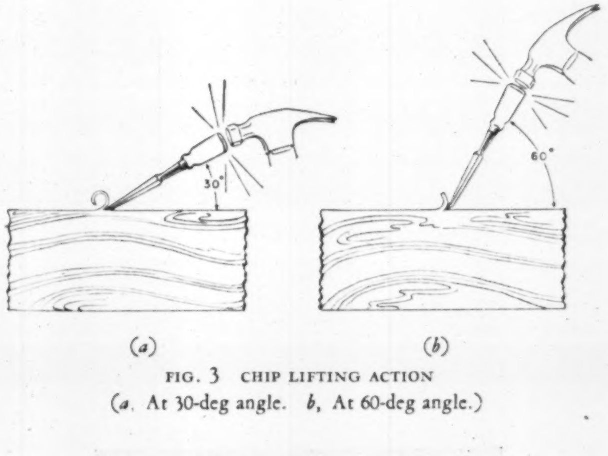


FIG. 2 TANGENT LINE REPRESENTS 30-DEG HOOK

matter of a few degrees, or to some specific fitting for a particular job. Basically, hook is that angle which permits the tooth to cut or lift the chip with the least possible effort. It may be considered as the best angle to use a chisel in cutting a groove lengthwise with the grain of the wood.

Anyone who has used a cabinet chisel at a workbench has found that a properly sharpened chisel will cut more efficiently at some angles than others. This will also depend on the kind of wood being cut. The nearer a chisel approaches an upright position of 90 deg with the work, the greater will be the power needed to remove the chip. It is just as apparent that holding the chisel more nearly parallel to the work likewise will produce its problems, Fig. 3. Too little included angle will be required and will decrease the cutting life of the chisel or the saw-tooth. There must be, then, some workable angle in between which will give the best cut with the least possible effort and product the most satisfactory result for the greatest number of operations.

In some ripping operations several factors must be considered in order to produce a satisfactory ripsaw to meet the customer's needs: It is here that difficulties arise. The average ripsaw with the 30-deg hook is sold universally and, in many instances, distributed through a jobber who may know much or little about sawing operations. A customer buying a 14-in-diam 30-tooth ripsaw will get one with the standard hook as set up by that particular manufacturer. He may be cutting soft pine, dry or wet, gum, tupelo, poplar, hackberry, soft maple, hard maple, walnut, mahogany, or any one of a vast number of woods used in manufacturing our numerous wood products. To manufacture a saw for each type of operation which might be encountered would require almost unlimited manufacturing facilities, increased stock, and prices all out of proportion to the job to be done. It is here that the user and his maintenance department play such an important part. This will be discussed in more detail later. Various woods, specific operations, and conditions, all contribute their problems to the successful or unsuccessful operation of any saw.



(a) (b)

FIG. 3 CHIP LIFTING ACTION
(a, At 30-deg angle. b, At 60-deg angle.)

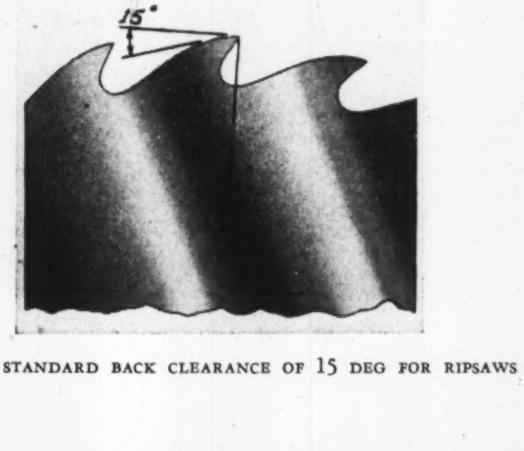


FIG. 4 STANDARD BACK CLEARANCE OF 15 DEG FOR RIPSAWS

Back Clearance. Back clearance is a matter which can be determined readily and is shown graphically in Fig. 4 which represents a circular saw. Most saw users will agree that the faster the feed and the greater the chip load, the greater must be the back clearance. Since the material is moving into the saw continuously there must be sufficient clearance or angle on the back of the tooth to keep it clear of the bottom of the kerf. Most ripsaws will work satisfactorily, even at 200 fpm feed, with a 15-deg back-clearance angle. A curved back has been most satisfactory in providing strength back of the point. However, there are some saws with flat or straight-angle backs which work satisfactorily, Fig. 5. The curved back, through practice, use, and design of saw-sharpening machines, has been almost universally accepted.

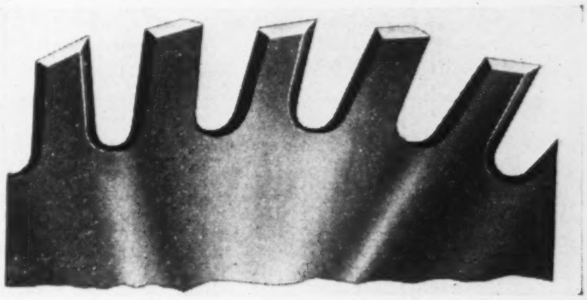


FIG. 5 MCKAM-TYPE TOOTH WITH STRAIGHT FRONT—TOP AND BACK

Gullet. While the gullet, Fig. 4, is not usually written in as part of the specifications, nevertheless it is an important factor in the operation of any saw, whether rip, crosscut, or combination. Once the chip has been lifted in a ripping operation, means must be provided for removal of that chip easily and with the minimum of friction or carryback. In examination of many ripsaws there is usually one indication of the chip removal which is easily visible. If the saw has been in use for any length of time without regumming, the path of the chips can be traced by the brightness of the gullet. This is especially true of tipped saws where the sharpening is usually confined to the tips. If the gullet is bright from the tip to a point well around the base of the gullet, the saw can be said to have a well-formed gullet.

The foregoing statement about ripsaws will hold true to some extent for crosscut saws. While the chip removal for a crosscut saw is distinctly different, the principle of each tooth removing the material it cuts each revolution holds true. Whether rip or crosscut, it is imperative that each tooth remove the material it cuts without excessive loading. Chips and sawdust will not flow out or clear themselves when the gullet has sharp corners. The failure to maintain properly shaped gullets in subsequent sharpenings contributes in no small way to lost efficiency in cutting and increased production costs, Fig. 6.

Saw Set or Kerf Clearance. There are two main types of "set" or side clearance for ripsaws, i.e., spring set and swage set, Fig. 7. The question of which is most successful or efficient is one of the best topics over which to start a good argument. Each method has its boosters and its critics. However, there are some points on which most users and filers will agree. Since a saw cuts on the points, it must be noted that a swaged tooth gives twice as many cutting points per side as is possible with a spring-set saw, Fig. 8. On a 30-tooth ripsaw, with

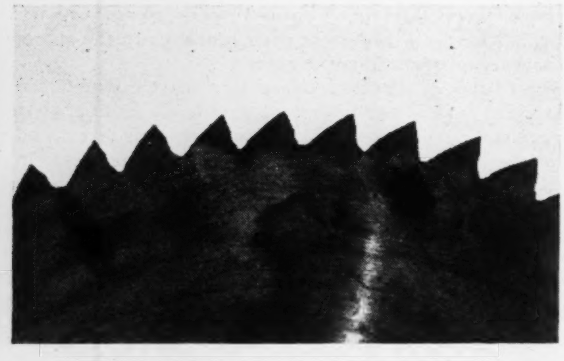


FIG. 6 IMPROPERLY FITTED CROSSCUT SAW
(Teeth are uneven and have sharp corners in gullets.)

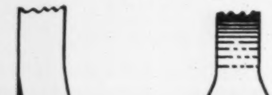


FIG. 7 TYPES OF SAW SET
(*a*, Spring-set teeth. *b*, Swaged teeth.)

swaged teeth, the outside points of each tooth cut, giving 30 cutting points on each side. A 30-tooth spring-set ripsaw provides only 15 cutting points on each side. The work in refitting the two types accounts for much of the difference in opinion. The spring-set saw requires less costly equipment and a less experienced filer. A suitable anvil and a setting hammer are the minimum requirements. These two items are inexpensive and easily obtainable. The set of a spring-set saw should not extend down more than $^1/_3$ of the depth of the tooth gullet, Fig. 9. To swage a saw correctly requires a good swage and a swage shaper. While not unreasonable in cost, they represent an outlay of many times the cost of spring-setting equipment. There are many excellent examples of cutting by both spring-set and swaged saws on similar materials. The differences, therefore, are a matter of opinion.

In flat-ground crosscut saws, the clearance is limited to spring-set, Fig. 10. Many types of hollow-ground or clearance-ground saws are available. These saws give excellent results when they are applied to work for which they were designed. There is, without a doubt, more abuse of hollow-ground saws, Fig. 11, than of any other type in the remanufacturing field. This may be accounted for, in part, by overly enthusiastic advertising. Many have gained the impression that the use of a hollow-ground saw on ripping operations will eliminate automatically all other finishing operations. The disappointments have been numerous, yet the saw is not entirely to blame. Incorrectly adjusted machines, improper applications, and careless operation and maintenance, all contribute their share to these unsatisfactory operations.

A saw manufacturer recently received a complaint from a customer who had attempted to run hollow-ground combination saws on a gang rip to produce advertising yardsticks

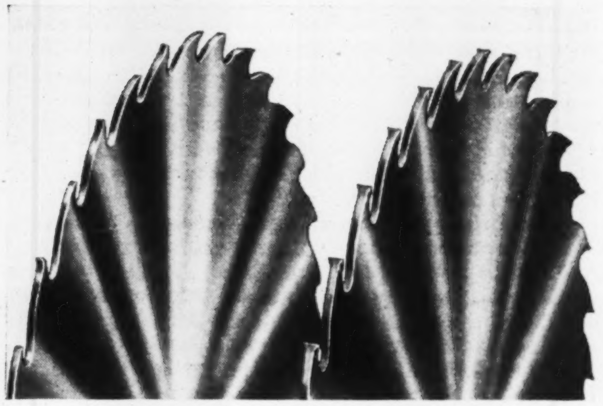


FIG. 8 SPRING-SET RIPSAW AT LEFT, AND SWAGED-TOOTH RIPSAW

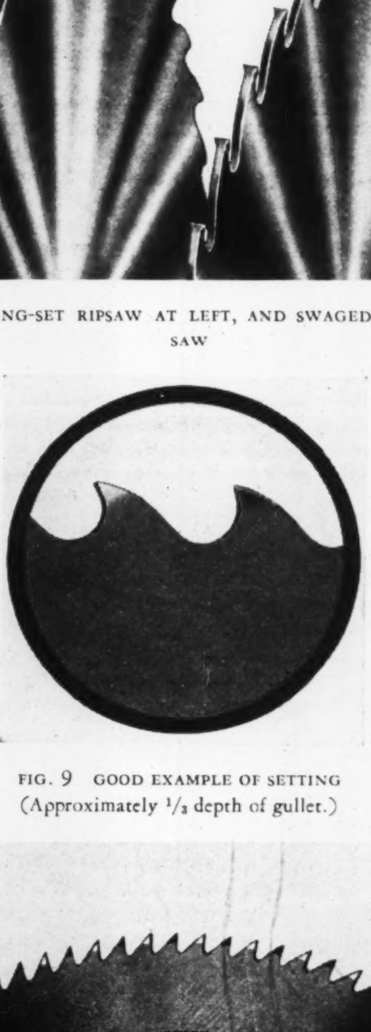


FIG. 9 GOOD EXAMPLE OF SETTING
(Approximately $^1/_3$ depth of gullet.)

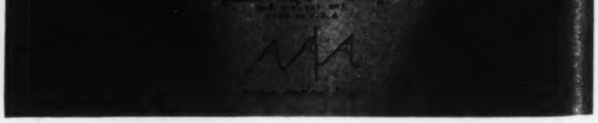


FIG. 10 CROSSCUT SAW PROPERLY SET
(Etch showing shape of tooth as it appears on most saws)

after sawing. This problem was solved, but not with a hollow-ground miter saw. Inaccuracy in clearance, whether it be by setting, swaging, or hollow grinding, will produce inaccurate cutting. The amount of set will vary from a few thousandths per side to one half of the thickness of the saw on each side for rough-cutting in wet lumber. Here again, it is difficult to say that any certain amount of set will work in all cases. The various woods will establish certain requirements for the amount of set they need. Generally, the more gum or resin a wood contains, the greater the set. Wet woods require more set than dry of the same kind.

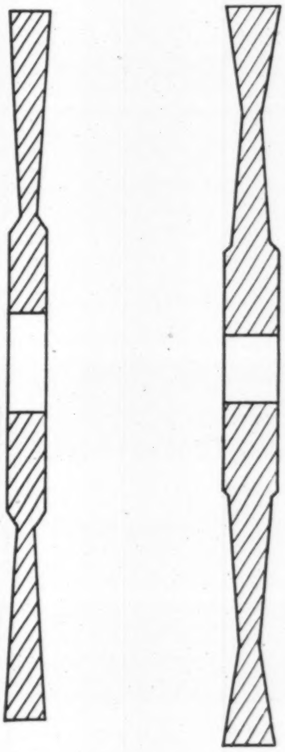


FIG. 11 STANDARD TYPES OF HOLLOW GRINDING

Operation. This phase is the responsibility of the user of the equipment. The machinery builder and the saw manufacturer may make certain suggestions and recommendations, yet in actual production, the operating procedures are the responsibility of the user. When he buys and pays for a piece of equipment or a tool, he retains the privilege of using it as he believes it will best fit his needs. However, more and more users are recognizing the fact that the machinery builder and the saw manufacturer are valuable sources of information on operation practices. Manufacturers of machines and saw blades are receiving more and more calls for advice and suggestions as to the best way to solve various production problems. The actual operation of an expensive machine, equipped with the best cutting tools available, can be and is a matter of real concern to all interested in efficient and economical sawing practices. Prevention of the abuse of the machine and the cutting tool is an accomplishment which requires constant vigilance of supervisors. Managers and superintendents of plants have made this same complaint: "It's hard to find men who have a desire to get the most from a machine and cutting tools without damage to either." Records of many plants operating several machines of the same make, cutting similar materials, will disclose a wide variance in production and upkeep costs. The operator is still the unknown factor in this equation. Both careless feeding of machines and running a saw far beyond its efficient cutting time contribute to increased manufacturing costs and lowered production. More efficient and more economical operation cannot come from better machines and better tools alone; it requires intelligent co-ordination of all factors.

MORE ACCURATE MACHINES NOW BEING PRODUCED

The sawing-machine manufacturer has his part in providing economical and efficient sawing operation for the user. Today, there is more evidence of co-ordination between the machinery builder, the saw manufacturer, and the user than ever before. This is indeed a healthy sign. Manufacturers of power-saw machines are producing more accurate machines for more economical and efficient operation. The matter of variable arbor speeds is being considered by some manufacturers. Faster and more accurate feed arrangements are producing more linear footage of cutting per day than was thought possible even 15 years ago. It is hoped that there will be papers from machinery manufacturers at future meetings.

When the materials to be cut are changed in grade, thickness, or condition, there should be careful consideration given to the number of teeth, arbor speed, and the rate of feed. Usually only the number of teeth, and the rate of feed are adjustable. With the introduction of accurately built power-feed ripsaws has come the demand for glue joints directly from the saw. This is a logical requirement. It represents a saving in material and elimination of at least two additional handling operations. The introduction of the newer resin glues has brought the additional problems of producing a sawed glue joint, and of overcoming the abrasive action on the saws used for trimming to size.

The desire for decreased kerf is a most important item and one which merits the co-ordinated efforts of all parties concerned. With present equipment, speeds, and methods of feeding, there is a limit beyond which it is uneconomical and inefficient to go. It might be stated that most export saws are of thinner gage of the same diameter than are our domestic saws. In other countries, where necessity has forced the conservation of timber supply, their waste is considerably less than ours. A movement is now under way to co-ordinate the efforts of lumbering interests, machinery builders, saw manufacturers, and large consumers in a definite program pointed toward greater utilization of our timber resources. The Forest Products Research Society, with many of the larger and smaller plants represented in its membership, is undertaking a program of this kind. There can be no doubt that the operation and maintenance of machines and tools are the responsibility of the user.

MAINTENANCE OF EQUIPMENT

Maintenance is an extremely important factor in the problem of economical sawing procedures. The work of the filer is of the utmost importance. Without accurate intelligent refitting, it is impossible to maintain efficient and economical operation. Saws have been sent in to saw manufacturers for credit or repair so carelessly filed that they had the appearance of an ellipse. By actual test on one 36-tooth ripsaw, it was found that only 7 of the 36 teeth were near enough to the same diameter to be cutting when in operation. That represents about 19 per cent efficiency—yet the customer asked for replacement of the saw as it was cracked. It was a wonder that it had cut at all. Many plants spend almost unlimited amounts for production equipment and then apparently buy their maintenance equipment from the petty-cash fund.

Observation indicates that a well-equipped filing room with a good filer will do as much to reduce production costs as will expensive production equipment and an inadequately equipped filing room. The fact still remains that, regardless of how much is paid for a machine, the cutting tools do the work. Correctly fitted tools will reduce the wear and tear on machines. If saws or tools are out of balance, with only a portion of the teeth cutting, unnecessary strain is imposed on the arbor and on the entire machine. Maintenance equipment and personnel should be checked carefully; it will pay dividends in lower production costs, uninterrupted production, and lower tool costs.

As a case in point: at one plant in the South, which has excellent production equipment, the equipment in the filing room is inadequate and worn out. The cutter-head grinder is so old and worn that it is impossible to grind a straight edge. The saws and knives are being sharpened inaccurately and much too often, in an effort to keep up production. Three thousand dollars spent for sharpening equipment in this filing room would increase plant production and lower its costs.

TIPPED SAWS

Today, tipped saws are in greater demand than ever before. With few exceptions these saws are tipped with one of the many grades of tungsten carbide, Fig. 12. The results obtained have been as varied as the applications. The whole problem has been a matter of trial and error from which have come some few standards. In the eagerness of the saw manufacturers to produce a long-life saw, they often have used a grade of carbide much too hard for the successful operation at the speeds and feeds required in the woodworking industry. In so far as is known no tungsten-carbide manufacturer has yet produced a tungsten carbide to be used exclusively in the woodworking industry. The woodworking industry needs a material which will have the following characteristics: (1) Resistance to shock, (2) resistance to abrasion or wear, and (3) ability to hold an edge even on the thin cutting edges used in the woodworking industry. When asked for such a material, one carbide manufacturer replied: "Well, that certainly wraps it all up in one package." There is no doubt but that tungsten carbide will hold a cutting edge longer than standard saw steel. This has caused some discussion as to the necessity for such thin edges. If the theory is accepted that it is the points which cut and that carbide holds its edge much longer, then there is reason to question these sharp thin edges. Some experiments have proved that less included angle can be used. However, more exhaustive tests are needed before any standards can be set.

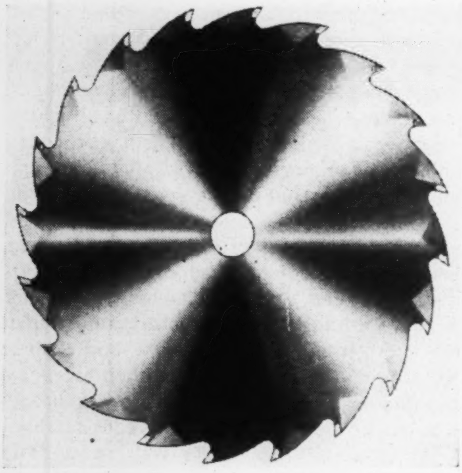


FIG. 12 TUNGSTEN-CARBIDE-TIPPED RIPSAW
(Saw has standard hook and back clearance.)

The tipped saw has begun to take its rightful place in the woodworking industry. It is not a cure-all, nor is it always economical to use. Where it can be used, lower production costs are almost universally true. This type saw is lending itself admirably to the demand for the reduced kerf. This subject should be treated separately at some future time, since the customers are demanding less kerf in order to reduce waste and increase the number of pieces from each thousand board feet of lumber.

This matter of economical and efficient sawing will require the concerted efforts of all concerned; the machinery builder, the saw manufacturer, and the user, if satisfactory solutions are to be found. In discussing these various phases of sawing operations the effort has been made to stimulate thinking along these lines. It is possible that readers will not agree with every statement, and that is as it should be, because differences of opinion are the foundation of real research and development.

This paper has touched but briefly on the many factors involved in efficient and economical sawing. There is an old axiom which carries a fundamental truth, "There is nothing as permanent as change." There will be changes in saw design as customers demand them to meet changing production needs.

Basic changes in saw specifications are few. Such changes as are made come as a gradual development. There is no doubt that this subject can be broadened in future discussions so that all individuals and groups will benefit. All efforts should be co-ordinated toward that end.

Record Air Speed

A SIMULATED air speed of 5.18 times the speed of sound—highest ever attained in large-size tunnels in the United States—was achieved recently in the modernized and reconstructed German supersonic wind tunnel now in operation at the Naval Ordnance Laboratory, according to the NOL *Report* for November, 1948.

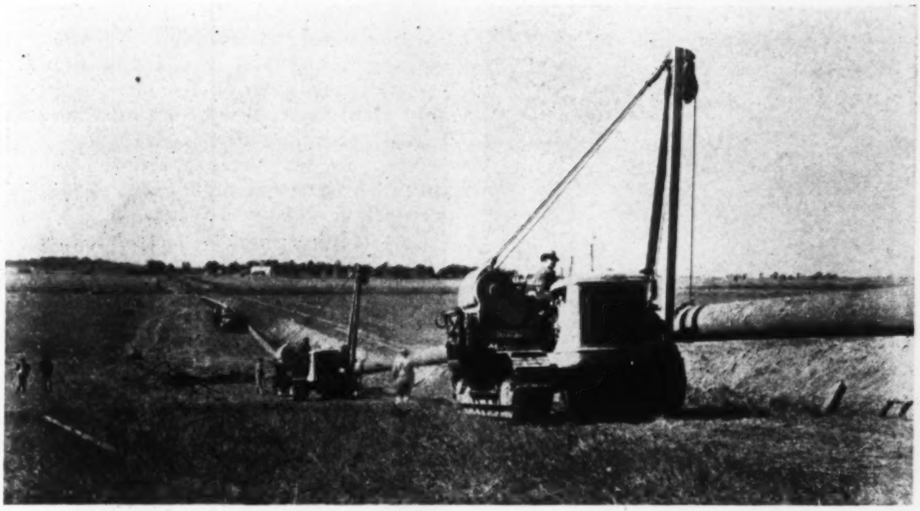
This speed is the equivalent of 3960 mph under normal conditions. However, the speed of sound decreases with the drop in temperature, and since the temperature in the working section of the tunnel at the time was 377 F, the simulated speed was recorded as 1580 mph. The figure represents 93 per cent of the absolute speed of air under any conditions—1700 mph.

The event was immediately hailed by Dr. Ralph D. Bennett, technical director of the Laboratory, as one of the first important steps in the Navy's development of weapons for use at supersonic speeds. "The achievement," said Mr. Bennett, "of a steady air flow at Mach numbers above five, in a working section of significant dimensions, augurs well for our success in developing weapons which the Navy and the nation may sorely need in the future.

"Most nations, including our own, are doing extensive work in developing aircraft to fly at or above the speed of sound. Obviously, projectiles fired from these aircraft in pursuit, or at them in antiaircraft defense, must travel at several times the speed of sound if they are to be effective.

"The fact that Laboratory scientists have achieved a record speed at such an early stage of NOL's program is an encouraging and highly significant development. It places the Navy and the Bureau of Ordnance well in the forefront of what may prove to be the most important field of ordnance work in our generation."

The high speed was attained in the 40 × 40 cm working section of the NOL tunnel.



PIPELAYING EQUIPMENT BUILT OF WELDED CONSTRUCTION
(Model illustrated has capacity of 28,000 lb. Sudden loads caused by pipe movement and slipping impose high impact conditions on equipment.)

The COMMERCIAL WELDERY

A New Service and Tool for Industry

By KENNETH F. ODE

WORKS MANAGER, TRACKSON COMPANY, MILWAUKEE, WIS.

INTRODUCTION

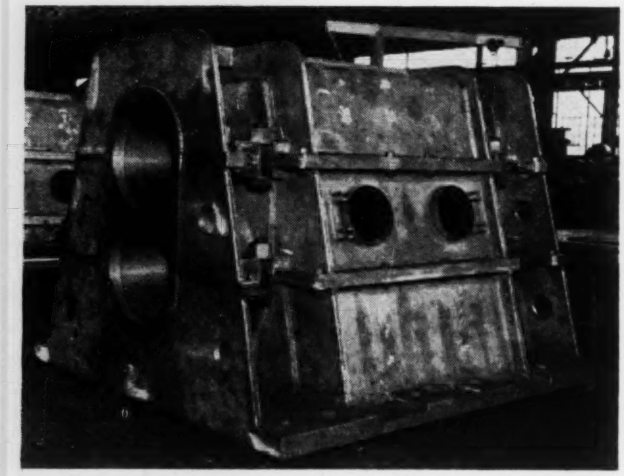
CONSTANT reference is made to our amazing industrial progress and, while it is evident that the past 170 years in America have seen greater advances than those achieved in the previous 6000 years of civilization, a closer analysis reveals that, with the exception of the past two decades, all machine parts were made exclusively by the metal-founding, the forging process, or some variation thereof. It is true that tremendous advances have been made in these processes, but during all this time no really new method of fabrication was developed. Our entire civilization was developed on two processes, centuries old.

While welding as a manufacturing tool has existed for about 30 years, its commercial feasibility only became apparent about 15 years ago. In the period from 1933 to 1943, weld-rod consumption per ton of finished steel produced increased over 10 times. This progress is outstanding, and, for the first time in centuries, man had a really new manufacturing tool. By the simple application of an electric current we were able to join two pieces of metal into an integral part with a speed and freedom from limitations never before possible. Metal could be placed where design requirements indicated it was needed, alloy steels with their specific properties could be used only where service demanded it, surfaces could be given overlays of hardened steel where abrasive-resistant qualities were recommended. All of this could be accomplished by equipment investments far below that required using the older processes of fabrication.

Welding has crept into our modern life with unobtrusiveness and efficiency. It is perhaps the greatest single factor that has permitted manufacturing efficiencies never before obtainable. An example of its tremendous range of application is the automobile. Imagine the present-day car being produced without the use of welding. The body alone contains thousands of spot welds, and, if the conventional methods of fastening and joining were used, the price of a car would be well beyond the range of practically everyone.

Mass-production industries were the first to realize the potentialities of welding, and no expense was spared on development and design, until today it is difficult to find any consumer-goods product made of metal which does not use welding wherever possible. Welding progress in the heavier and less repetitive industries has not been anywhere near as spectacular. In the author's opinion this has been due to several factors, not the least being a lack of understanding of welded design possibilities, and a natural reluctance to change as long as the existing method is acceptable. The inevitable disappearance of the present seller's market will force many manufacturers into considering new designs for economy. When this occurs, welding will take its rightful place beside the casting and forging industry. The use of welding in the durable-goods industry has been hampered by the absence of qualified engineers who could advise and consult with the design groups concerned. It is interesting to note that the products of new companies and many new products of old established companies are almost entirely welded.

Contributed by the Production Engineering and Machine Design Divisions and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.



COMPOSITE STEEL-PLATE AND STEEL-CASTING GEAR CASE

(Cast-steel bearing blocks would be impractical cut from heavy plate, and thin walls with heavy bearings would have been difficult and expensive to cast. This design is both economical and pleasing in appearance.)

Unquestionably, the lack of competent designers has prevented considerable conversion, but few manufacturers have realized that the recognized commercial weldery can be of service in this respect. The commercial weldery knows the limitations of welded design, as well as its advantages. Personnel from these organizations is always available for design counsel. Their analysis of a structure and constructive criticisms can prevent later unsatisfactory performance.

Many industries have been slow to realize that we are on the threshold of a new industrial-design era. Large and heavy machinery is being welded, steel buildings are being welded as fast as codes can be changed, tanks of all varieties, bridges, aircraft, and road and farm machinery are all being converted to welded design.

Government and private schools, and those operated by industries have turned out thousands of operators. Private research by industrial companies and universities is solving welding problems and advancing our knowledge in this field so that America in its postwar development can use this process to its fullest extent.

CONSIDERATIONS FOR WELDED DESIGN

The fundamental reasons for determining whether a weldment is to be used must first be determined and defined so that the approach will be analytical and complete.

First we must consider the inherent advantages of the material. Steel used in plate and structural assemblies is the most homogeneous and consistent commercial material available today. When the physical characteristics are compared to those of cast iron, the superiority is immediately apparent. The measure of rigidity or modulus of elasticity is from 2 to $2^1/_2$ times greater for steel. In tensile properties, steel will be from 3 to 6 times greater. For impact loadings, 3000 psi is generally allowed for cast iron and 15,000 psi for steel—a difference of 5 times! This factor is often overlooked in the design of structures subjected to dynamic loading and, if the parts are in motion, the reduction in weight and, consequently, in inertia forces by conversion to steel is apparent.

Another design factor to be remembered is that the strength of cast iron is generally determined from samples cast for this specific purpose. These specimens are generally no greater than 1 in. thick and, obviously, cool at a rapid rate. A slower rate of cooling results in a greater amount of graphitization, and its resulting adverse effect on tensile strength. In a casting, the cooling rates vary, and it is readily apparent that in heavy castings this variable-tensile-strength phenomenon is quite pronounced. Steel is not so affected and does not vary in strength regardless of size or shape. Elongation differences between the two materials are well known to all designers; they are practically zero for gray iron and 20 per cent or greater for steel.

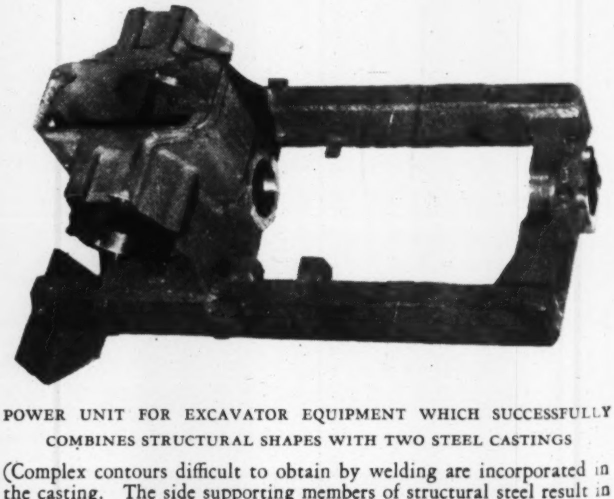
The old statement, "We must have cast iron in this structure because we need rigidity," is constantly encountered. The values previously shown for the modulus of elasticity readily indicate a lack of understanding regarding the physical properties of the two materials, and that actually a weldment need only weigh about one half as much to obtain the same stiffness and rigidity. If stiffness is not a factor, a weldment may weigh as much as one fourth, because of the higher tensile properties of steel.

When steel fabrications are compared with steel castings, the material advantages which exist in the case of gray iron do not hold; however, many of the same design limitations inherent to castings still prevail.

Another factor to be considered in welded design is the adaptability of the structure. It is not sufficient or good practice to duplicate the casting. The design must be approached entirely on a functional basis. We must expect the weldment to look different because it has been made by a radically different process. In fact, the author has adopted the practice of viewing critically any weldment which does not appear different from a casting, because it is generally safe to say that all of the possible economies have not been effected.

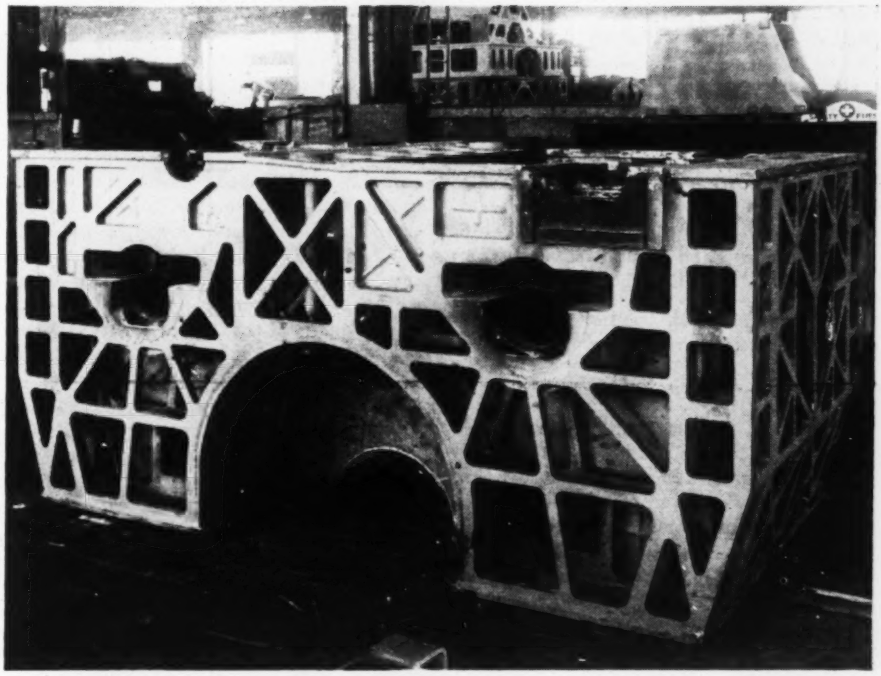
Welded construction eliminates original pattern costs and subsequent pattern repair or change charges. Another advantage from the designer's standpoint is the fact that special machines do not have to be designed to existing patterns. The engineer is free to design every machine with complete freedom. Welding is the only process which permits the placing of special steels where their desirable properties can be used in higher stress areas. On areas subjected to abrasion, hard-surfacing alloys can be used. Variations of this type are not possible with castings.

In weldments above 250 or 300 lb, welding generally can be applied successfully, particularly where weight reduction is a factor. This is because welding permits thin sections not possible in the casting process. Many successful weldments



POWER UNIT FOR EXCAVATOR EQUIPMENT WHICH SUCCESSFULLY COMBINES STRUCTURAL SHAPES WITH TWO STEEL CASTINGS

(Complex contours difficult to obtain by welding are incorporated in the casting. The side supporting members of structural steel result in maximum rigidity with minimum weight.)



WELDED MARINE GEAR CASE COMBINING MAXIMUM RIGIDITY WITH MINIMUM WEIGHT

(Steel need be placed only at required locations instead of where steel-casting requirements dictate.)

in use today have plate thicknesses of $^1/_8$ to $^1/_4$ in. in sections which would be unobtainable in castings. A classic example of this type is the welded Diesel crankcase developed during the recent war. The decision to use welding in this construction permitted considerable weight reduction and reduced breakage which was always present in the previous design. In cast crankcases, gear cases, and similar parts, used to enclose machinery, constant care is necessary to remove all sand, scale, and the like. Weldments eliminate this danger. Leaks due to porosity and sponginess are nonexistent in steel-plate construction.

Everyone is familiar with the exasperating experience of spending considerable time and money machining a casting, only to find hidden defects which require considerable repair and remachining, or even complete scrapping of the casting. The susceptibility of gray iron to breakage, and the difficulty of repair result in considerable loss during manufacture or end use.

The designer should never lose sight of the simplification and elimination of parts that is possible by the use of welded design. Many types of structures can be made integral which would be impossible as castings or forgings without the use of excessive machining, bolting, and keying.

The use of composite structures, that is, the joining of steel plate with steel castings, offers a fertile field for development. Many structures have sections which can be most economically designed as steel castings, while the other parts of the structure are better adapted to place construction. Unfortunately, too many designs do not use the advantages inherent to each process. The illustrations show some of the progress made in this respect. The road machinery shown is of the repetitive type and the generous use of castings has resulted in an excellent design which has performed very well under the severe and unpredictable impact conditions existing in this application. The other designs are in the heavy special machinery field. This work is generally of the nonrepetitive type, and castings for bearing blocks, thrust blocks, and the like, have resulted in economical, well-engineered structures.

Close co-operation and counsel with steel-foundry operators are necessary, and it is logical to assume that from this association greater opportunities for the foundryman and welder are inevitable. The method of price scheduling employed by most steel foundries has been the reason for some adverse criticism and, in the author's experience, has been responsible for the reluctance of some companies to use steel castings to their fullest extent. The increased use of weldments in applications where castings are indicated may result in some future adjustments in this respect.

The machining of weldments offers many advantages and should always be taken into account in cost comparisons. The higher rigidity permits heavier cuts, and the fact that welded design generally permits closer finish tolerances reduces the machining time. Increased tool life, because of the absence of sand and scale, is often of considerable consequence. Weldments are furnished to the customer with more accuracy than the average casting and, consequently, the time involved in laying out for machining is considerably reduced. The smoother surfaces in certain applications eliminate machining entirely and reduce final painting or other finishing costs.

There are some factors of design which should be given special attention and care. This is especially true in all designs involving dynamic loading. It is important that abrupt changes of stiffness should be treated with the same respect that has always been given abrupt section changes. Attention to this feature can reduce the possibility of failures, particularly on dynamically loaded structures. Our present-day lack of experimental stress analysis is resulting in a certain amount of overdesigning and overwelding. Consequently, exhaustive testing on repetitive structures might well be justified in order to effect maximum manufacturing economies.

When failures occur it is important that an unbiased and complete study be made. All of the factors contributing to the failure must be considered. Too often the deficiency has been found to be in the design and not in the process. Consideration should also be given to the possibility of the part having been subjected to abnormal service. Castings and forgings are still better and more economical in certain applications, and the engineer must bear their desirable features in mind. The interest in welded design must not be allowed to interfere with good judgment. Misapplication serves no useful purpose because sooner or later the best method will prevail. The welding industry has suffered, as most new methods and developments have, from overenthusiasm, and many parts and structures have been welded which should have been fabricated by some other process.

WELDMENTS AND PRODUCTION COSTS

Increasing labor costs, higher machinery investments, rising ratios of indirect labor to direct labor, and higher break-even points are forcing economies of manufacturing which cannot always be achieved unless new designs and processes are completely explored. The rapid strides made in the welding field in the past few years have resulted in many new concepts of construction which have not yet become general engineering knowledge. Consequently, when considering the use of weldments, the advice and help of men who owe their livelihood to this process should be sought in much the same way that the designer consults the foundryman. While the actual process of welding is quite simple, the design and manufacture of weldments is in many instances a problem for the commercial weldery to consider.

The well-equipped weldery has many facilities which cannot be justified for the low-volume nonrepetitive production inherent in many industries. Few manufacturers would consider the installation of a foundry for the manufacture of their castings, and yet they unhesitatingly buy some welding machines and a press brake and start producing their product. All too often the volume does not permit the proper facilities or technique, and the costs are too high or the product unsatisfactory from a performance standpoint. These experiences have affected welding adversely and its deserved progress. The competent commercial weldery can and has proved to be the solution to many of these production problems.

The adequate jobbing weldery has equipment for bending, pressing, stress-relieving, blasting, premachining, final machining, and other miscellaneous operations. By experienced design and the use of proper equipment, the weldery is generally able to effect economies that well justify any conversion problems or costs. It is important that manufacturers start to consider weldments from the jobbing standpoint, in the same way that they have always viewed castings.

While many of the design considerations in converting from castings or forgings to weldments have been mentioned previously, no comment has been made on the cost comparisons. Actual direct cost comparisons are dangerous and in some cases impossible. Too many times welded design is considered entirely on a cost basis, and no allowance or credit is given to the engineering or manufacturing problems which may be reduced or eliminated. Generally speaking, if a comparison is made, it should be on a finish-machined basis, and due allowance made for scrap. The weight reduction which generally results makes price-per-pound comparisons misleading. In the analysis, all the credit due should also be allotted to the relative merits of the materials and processes.

It is equally important that the freedom permitted by the welding process, and any improved efficiency of the finished product be properly evaluated and brought to the attention of the persons responsible for making the final decision. This demands that the executive engineering staff completely inform all concerned on the merits of welding. In cost comparisons it is well to keep in mind that the first conversion to weldments is being compared costwise with what may represent the culmination of many casting and forging changes and improvements, and it is logical to assume that future and improved welded designs will result in even a better cost presentation. Quite obviously, if welding does not result in reduced cost and/or improved product efficiency, it is not the process to use because it is not good business sense to pay a premium for a product which does not contribute something extra.

When a design is to be submitted to a weldery for consideration, it is important that sufficient information be furnished so that a bid covering all operations desired can be obtained. If any question on the feasibility of performing some of the operations arises, it is suggested that the advice of the weldery be requested. A possible information list will include the following directions:

1 Steel specifications.
2 Standards of welding and weld sizes.
3 Over-all tolerances and any special or close tolerances. Use good judgment and consult with weldery if necessary.
4 Sand, grit, or shot-blast finishing.
5 Stress-relieving.
6 Any special chipping or grinding.
7 What inspection necessary beyond general practice. Is outside agency to be employed?
8 Must the structure be x-rayed? If so, what code must be considered?
9 Must the structure be oiltight, or pressure-tested? If so, at what pressure and by what methods?
10 Type of paint to be used and how many coats?
11 Delivery required, if all the pieces are not necessary immediately what is earliest delivery required and at what rate?

If the final bid appears too high, consult with the weldery and find out the specific reasons for the high cost. A compromise design perhaps can be developed that would prove to be of mutual benefit.

CONCLUSION

Welding should never be employed solely because of a desire to use this medium. When castings or forgings have been difficult to obtain, welding has been resorted to successfully, but, it still may not be the most economical method. Remember that each process and material has inherent advantages, use them to their fullest extent and at all times be willing to expect and accept a change in appearance. Do not try to convert to welded design a part or a structure which obviously should be a casting or a forging. Devote attention to parts which have proved to be expensive or unsatisfactory by the former processes. The author has found that, invariably, the most spectacular results have been obtained by a selection of this sort.

If failure does result, be thorough and fair. Study the breakdown and conditions surrounding it. Do not condemn the process because of misapplication or fundamental design weaknesses. Failures in secondary members can be puzzling and deceptive, and a very thorough diagnosis is suggested before the method is rejected.

Those who are intimately associated with this new activity are most fortunate in being able to guide and develop a new basic manufacturing process. With few exceptions, they understand their responsibility and realize that they are laying the foundations for a new industry whose progress is limited only by man's ability to further develop his imagination and to change his thinking on some of his previous concepts of design.

SOLVENT VAPOR CONTROL

By JOHN O. AMSTUZ[1]

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EXPLOSION HAZARDS

THE risk of explosion is frequently present when solvents are used in industrial processes. If the temperature of an inflammable volatile liquid is increased gradually, the air above the liquid becomes progressively richer in inflammable vapor. At a certain concentration the air-vapor mixture can just be ignited with a flame or a spark of sufficient thermal intensity and propagate a flame. This concentration in per cent by volume in air is called the "lower explosive limit" or LEL. As the concentration increases, it becomes easier to ignite the mixture, and the combustion becomes progressively more violent until a maximum is reached. A further increase in concentration will result in a gradual decrease in the violence of explosion until a point is finally reached where the mixture will no longer propagate a flame but will burn at the point of ignition. This point is called the "upper explosive limit" or UEL.

When inflammable solvents are used in saturating or coating continuous sheet materials such as paper or cloth, the evaporation occurs rather rapidly on account of the relatively thin coating films and the large exposed surfaces.

To prevent explosions it is necessary to keep the air-vapor mixture below the LEL around the coating machines, in the drying ovens, and especially near the surface of the coated sheet material. A safe practice is to keep the mixture well blended with air so that the calculated concentration never reaches more than 40 per cent of the LEL. To calculate the fresh-air requirement and the allowable concentration, it is necessary to refer to certain gas laws. These laws apply exactly only to a nonexistent perfect gas, but they are sufficiently accurate for engineering purposes for most actual gases, provided these gases are at moderate pressure and not too close to the point of condensation.

The first gas law to be applied is Avogadro's law. This law states that at any specified temperature and pressure, a given volume of one gas will contain the same number of molecules of that gas as are contained in the same volume of any other gas at the same temperature and pressure.

For example, 100 cu ft of oxygen at 50 F and 1 atm contains the same number of molecules as 100 cu ft of nitrogen at 50 F and 1 atm, or 100 cu ft of air at 50 F and 1 atm.

The same law holds true for pound-molecules of any gas. It is frequently convenient, in plant practice, to use as many pounds of a given substance as there are units in its molecular weight, calling such an amount 1 "pound-mol." Accordingly, 1 lb-mol of oxygen is 32 lb; 1 lb-mol of sulphuric acid is 98.1 lb. If there are 10 lb-mols of oxygen (320 lb) in a certain vessel, the same vessel, when filled with hydrogen or with nitrogen of the same pressure, will be found to hold 10 "lb-mols" of hydrogen (20 lb) or 10 "lb mols" of nitrogen (280 lb).

Reasoning from Avogadro's law, and its application to pound-mols, it is evident that 1 lb-mol of any kind of gas must occupy the same volume as 1 lb-mol of any other kind of gas, providing both are at the same temperature and pressure. It has been found that 1 lb-mol of any "perfect" gas at standard condition (1 atm or 14.7 psi and 32 F) occupies 359 cu ft. Actual gases are generally close enough to perfect gases, therefore the following statement can be made:

One pound-mol of any gas has a volume of 359 cu ft at standard condition of 1 atm pressure and a temperature of 32 F.

The law of perfect gases states: The product of the pressure times the volume equals the product of the number of mols of gas present, the absolute temperature, and a constant known as the gas constant R

$$pv = NRT$$

In using this formula, the gas constant $R = 1543$ when the variables are expressed in the following units:

p = pressure, in psfa
v = volume, in cu ft
N = number of lb-mols
R = 1543
T = absolute temperature, (degrees Rankine)

The (lowest conceivable) temperature at which matter contains no heat is —460 F. Measuring all temperatures above this absolute zero in degrees Fahrenheit gives the Rankine scale. In other words

Zero degrees Fahrenheit = 460 degrees Rankine
Freezing point of water = 460 + 32 = 492 R
Boiling point of water = 460 + 212 = 672 R

Example: At what pressure would 88 lb of carbon-dioxide gas occupy a volume of 100 cu ft when the temperature is 10 F?

$$N = \frac{88\text{ lb}}{\text{Mol weight of CO}_2} = \frac{88}{44} = 2\text{ mols}$$

$$v = 100\text{ cu ft}$$

$$T = 460 + 10 = 470\text{ R}$$

$$p = \frac{NRT}{v} = \frac{2 \times 1543 \times 470}{100} = 14{,}500\text{ psf}$$

$$\frac{14{,}500}{144} = 101\text{ psia}$$

$$101 - 14.7 = 86.3\text{ psig}$$

or volume of 1 lb-mol at standard conditions 32 F and 1 atm

$$v = \frac{NRT}{p} = \frac{1 \times 1543 \times (460 + 32)}{14.7 \times 144}\text{ cu ft}$$

$$v = \frac{1543 \times 492}{14.7 \times 144} = 359\text{ cu ft}$$

or at 70 F

$$v = \frac{1543 \times (460 + 70)}{14.7 \times 144} = 386\text{ cu ft}$$

or

$$v = 359\,\frac{(460 + 70)}{(460 + 32)} = 386\text{ cu ft}$$

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[1] Vice-President in Charge of Manufacturing and Engineering.

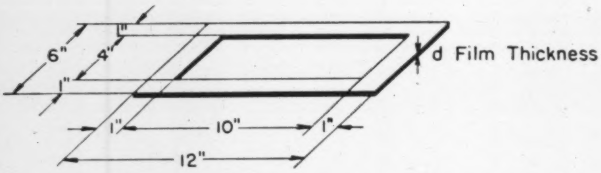

FIG. 1

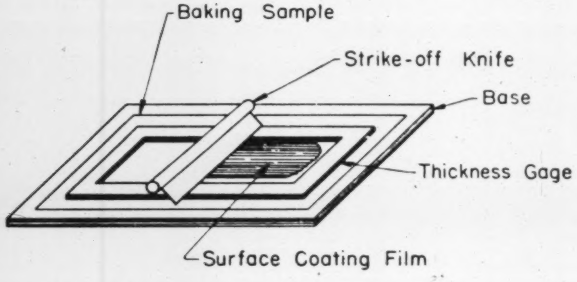

FIG. 2

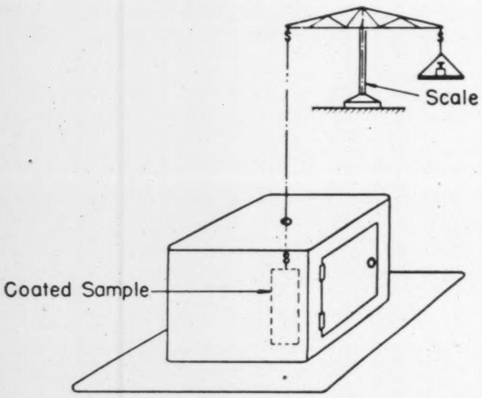

FIG. 3

In order to calculate fresh-air requirements to prevent explosive mixtures, it is necessary to know the rate of solvent evaporation. This rate must be determined for each coating solution for a number of representative temperatures and for representative film thicknesses of any surface coating to be applied.

The following procedure for determining the evaporation rate is recommended:

1 Cut a backing sample 7 in. × 13 in.

2 Place it on a flat ground base plate made of cast iron 10 in. × 16 in. × $^1/_2$ in. (or any other suitable material).

3 Place thickness gage made of metal, fiber, paper, or any other suitable material on top of backing (Fig. 1).

4 Pour enough coating solution into thickness gage to cover the inside area of gage.

5 Level solution with a strike-off knife as shown in Fig. 2.

6 Remove coated sample from base and thickness gage and cut sample down to $2^1/_2$ in. × 8 in. This is best done with a die. Be certain that the sample is coated completely and uniformly.

7 Place $2^1/_2$-in. × 8-in. sample immediately into an oven of the circulated-air type, having temperature and air-flow control. A balance is placed on top of the oven and an arrangement is made to suspend the sample in the oven from the beam of this balance by means of a wire running through a hole in the top of the oven (Fig. 3).

8 Start stop watch when sample is placed in oven and record weight of sample.

9 Continue weighing of sample at intervals and plot curve of weight loss against time.

10 Plot curve for different oven temperatures and air velocities; temperatures and air velocities to correspond with conditions on production unit (Fig. 4).

It is often difficult to estimate the "operating" air velocity in curing ovens or around coating machines, and it is therefore necessary to assume air velocities for the first plotting of an evaporation curve. After the air requirements for toxicity or explosion hazards are finally calculated, evaporation curves

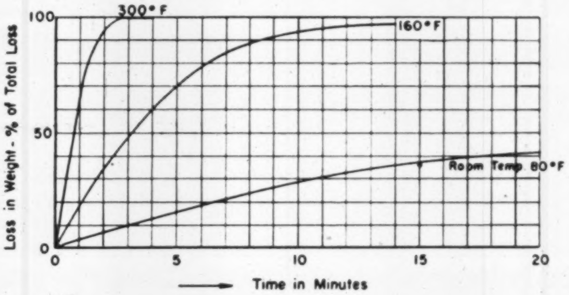

FIG. 4

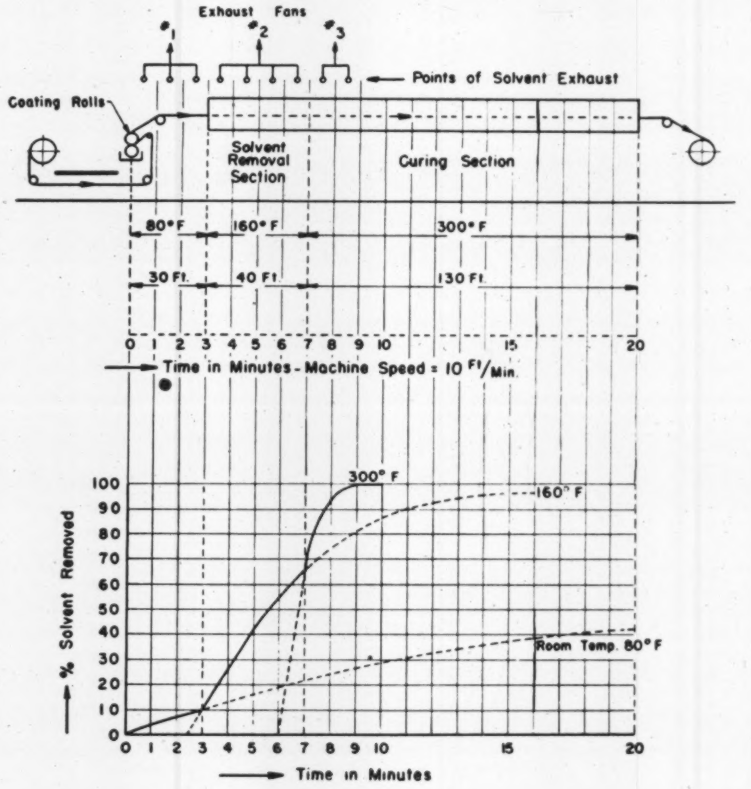

FIG. 5

TABLE 1 MOLECULAR WEIGHTS, MAXIMUM ALLOWABLE CONCENTRATION, LOWER AND UPPER EXPLOSION LIMITS OF GASES AND VAPORS

Substance	MAC[a] (ppm)	Molecular weight	Lower explosion limit (LEL)[b]	Upper explosion limit (UEL)[b]
Acetaldehyde	200	44.03	4.0	57.0
Acetic acid	10	60.03	4.0	...
Acetic anhydride	5	102.05	...	...
Acetone	500	58.05	2.15	13.0
Acrolein	0.5	56.03	...	...
Acrylonitrile	20	53.03	3.05	...
Ammonia	100	17.03	...	...
Amyl acetate	200	130.11	1.1	...
Amyl chloride	...	106.54	1.4	...
Iso-amyl alcohol	100	88.09	1.2	...
Aniline	5	93.06	...	...
Arsine	0.05	77.95	...	...
Benzene (benzol)	50	78.05	1.4	8.0
Bromine	1	159.8	...	...
1,3-Butadiene	1000	54.05	2.0	11.5
n-Butanol (n-butyl alcohol)	50	74.08	1.6	8.5
2-Butanone	200	72.06	...	...
n-Butyl acetate	200	116.09	1.7	15.0
Butyl alcohol-iso	...	74.08	1.68	...
Butyl "cellosolve"	200	118.11	...	...
Carbon dioxide	5000	44.00	...	...
Carbon disulphide	20	76.13	1.0	50
Carbon monoxide	100	28.00	12.5	74.2
Carbon tetrachloride	50	154.00	...	...
"Cellosolve"	200	90.12	2.6	15.7
"Cellosolve" acetate	100	132.09	1.71	...
Chlorine	2	70.91	...	...
2-Chlorobutadiene (chloroprene)	25	88.5	...	...
Chlorodiphenyl	1	188.65	...	...
Chloronaphthalene	1–5	162.51	...	...
Chloroform	100	119.39	...	...
1-Chloro-1-nitropropane	20	123.54	...	...
Cyclohexane	400	84.09	1.31	8.35
Cyclohexanol	100	100.16	...	...
Cyclohexanone	100	98.14	...	...
Cyclohexene	400	82.08	...	...
Cyclopropane (propene)	400	42.05	2.41	10.3
o-Dichlorobenzene	50	147.00	...	...
Dichlorodifluoromethane	1000	120.91	...	...
1,1-Dichloroethane	100	98.97	...	...
1,2-Dichloroethane (ethylene dichloride)	75	98.97	...	...
Dichloro ethylene 1,1	...	96.95	5.6	13.0
Dichloro ethylene 1,2	200	97.00	9.7	12.8
Dichloroethyl ether	15	143.00	...	...
Dichloromethane	500	85.00	...	...
Dichloromonofluormethane	1000	102.91	...	...
1,1-Dichloro-1-nitroethane	10	143.97	...	...
Dichlorotetrafluoroethane	1000	170.93	...	...
Diethyl ether	...	74.08	1.7	48.0
Dimethylaniline	5	121.09	...	...
Dimethylsulphate	1	126.11	...	...
Dioxane	100	88.06	...	...
Ether	400	74.08	...	...
Ethyl acetate	400	88.06	2.18	11.5
Ethyl alcohol	1000	46.07	3.28	19.0
Ethyl benzene	200	106.08	...	...
Ethyl bromide	200	108.96	6.75	11.25
Ethyl chloride	1000	64.5	3.6	14.8
Ethylene chlorohydrin	5	80.5	...	...
Ethylene dichloride	75	98.95	...	...
Ethylene oxide	100	44.03	3.0	80
Ethyl ether (ethyl glycol ether)	400	90.12	...	...
Ethyl formate	100	74.05	3.5	16.5
Ethyl silicate	100	208.22	...	...
Formaldehyde	10	30.02	...	...
Gasoline	500	120.00	1.3	6.0
Heptane	500	100.12	1.0	6.0
Hexane	500	86.11	1.25	6.9
Hydrochloric acid (ca. 31% HCl)	10	36.47	...	...
Hydrogen chloride	10	36.46	...	...
Hydrogen cyanide	20	27.02	...	...
Hydrogen fluoride	3	20.01	...	...
Hydrogen selenide	0.1	81.22	...	...
Hydrogen sulphide	20	34.08	4.3	45.5
Isophorone	25	138.2	...	...
Mesityl oxide	50	98.08	...	...
Methanol	200	32.04	...	...
Methyl acetate	200	74.05	4.1	13.9
Methyl alcohol (methanol)	...	32.03	6.0	36.5
Methyl n-butyl ketone	...	100.16	1.22	8.0
Methyl ethyl ketone	...	72.1	1.81	11.5
Methyl bromide	20	94.95	13.5	14.5
Methyl butanone (3-methyl 2-but.)	100	86.08	...	...
Methyl "cellosolve"	25	76.06	...	...
Methyl "cellosolve" acetate	25	118.08	...	...
Methyl chloride	100	50.49	8.2	19.7
Methylcyclohexane	500	98.11	...	...
Methylcyclohexanol	100	114.11	...	...
Methylcyclohexanone	100	112.09	...	...
Methyl formate	100	60.03	...	...
Methylpropyl ketone	1500	86.08	...	...
Methyl-iso-butyl ketone	100	100.09	...	...
Monochlorobenzene	75	112.56	...	...
Monofluorotrichloromethane	1000	137.39	...	...
Mononitrotoluene	5	137.13	...	...
Naphtha (coal tar)	200	125.00	...	...
Naphtha (petroleum)	500	145.00	1.2	6.0
Nickel carbonyl	1	170.69	...	...
Nitrobenzene	1	123.05	...	...
Nitroethane	100	75.05	...	...
Nitrogen oxides (other than nitrous oxide)	25	44.02	(monoxide)	...
Nitroglycerine	0.5	227.06	...	...
Nitromethane	100	61.03	...	...
2-Nitropropane	50	89.09	...	...
Nitrous fumes	10	46.00	...	...
Octane	500	114.14	0.84	3.2
Ozone	1	48.00	...	...
Pentane	1000	72.09	1.4	8.0
Pentachloroethane	2.4	202.29	...	...
Perchloroethane	30900	236.74	...	...
Phosgene	1	98.91	...	...
Phosphine	0.05	34.04	...	...
Phosphorus trichloride	0.5	137.39	...	...
Iso-propanol	400	60.06	...	...
Propyl acetate	200	102.08	2.0	...
Propyl acetate-iso	...	102.08	2.0	...
Propyl alcohol-n	...	60.06	2.5	...
Propyl alcohol-iso	...	60.06	2.5	...
Iso-propyl ether	400	102.11	...	...
Stibine	0.1	124.78	...	...
Stoddard solvent	500	130.00	...	...
Styrene monomer	200	104.06	...	...
Sulphur chloride	1	135.03	...	...
Sulphur dioxide	10	64.06	...	...
Sulphur trioxide	2	80.06	...	...
1,1,2,2-Tetrachloroethane	5	168.00	...	...
Tetrachloroethylene	100	166.00	...	...
Toluene	200	92.06	1.27	7.0
o-Toluidine (2-aminotoluene)	5	107.08	...	...
Trichloroethylene	150	131.38	...	...
Turpentine	100	136.00	0.8	...
Vinyl chloride (chloroethane)	500	62.48	4.0	22.0
Xylene	200	106.16	1.0	5.3

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[a] The maximum allowable concentration values (MAC) in parts per million (ppm) by volume, are those adopted by the American Conference of Governmental Industrial Hygienists at the 1947 meeting.

[b] The explosion limits are taken from the Associated Factory Mutual Fire Insurance Company Bulletin No. 36.10, January, 1945. The limits are expressed in per cent by volume in air.

should be rechecked with the air velocities actually encountered in the oven and around the coating machine.

After the determination of the rate of solvent evaporation, it is important to find at what stage and time interval of the coating process the solvent evaporation will occur on a production unit, for instance, at the point of application of coating solution, before entering the drier, in the drier or curing oven, and in what part of the oven. It is also necessary to know the coating speed of the production machine. The diagram, Fig. 5, will serve as an illustration.

Table 1 contains molecular weights, maximum allowable concentration, and lower and upper explosion limits of gases and vapors.

EXPLOSIVE DANGER OF SOLVENTS

It is not to be assumed that vapors are harmless, because no values appear in Table 1. Wherever solvent vapors are handled in a plant, it is recommended that solvent characteristics be checked with insurance companies, governmental agencies, or manufacturers in order to make certain that the correct and up-to-date values are applied in air-requirement calculations.

The range within which there is danger of explosion is sharply defined for every system of solvent vapor and air through the lower and upper explosion limit. Through addition of the vapor of another solvent these limits are changed. The lower explosion limit, according to Le Chatelier, can be determined approximately through the equation

$$\text{LEL } C_m = \frac{100}{\frac{p_1}{C_1} + \frac{p_2}{C_2} + \frac{p_3}{C_3} + \ldots\ldots}$$

in which C_1, C_2, and C_3 signify the lower explosion limit of each individual solvent in percentage by volume of air and p_1, p_2, and p_3 the percentage of the individual solvents in the mixture when

$$p_1 + p_2 + p_3 + \ldots\ldots\ldots = 100$$

or

$$\text{LEL } C_m = \frac{100}{\frac{30}{1} + \frac{40}{2} + \frac{30}{3}} = 1.666$$

or the LEL C_m of the mixture of three solvents in the percentage ratio of 30–40–30 with individual LEL of 1–2–3 = 1.666.

The foregoing of course applies only to explosive mixtures; not to mixtures of nonexplosive and explosive gases.

Knowing the solvent evaporation rate for a certain surface coat and film thickness at different temperatures, and approximate air velocities as encountered on a production unit, we are now able to calculate the air required in cubic feet per minute to prevent explosion hazards. The following steps are necessary for this:

1 Find from Table 1 the lower explosion limit (LEL) of the solvent in per cent by volume in air.

2 Determine safe operating conditions; for instance, 40 per cent of LEL.

3 Determine amount of solvent coated in pounds per minute.

4 Determine from the chart in Figs. 4 and 5 the amount of solvent evaporated in per cent per minute and calculate solvent evaporation in pounds per minute.

Example:

Solvent = xylene
Molecular weight = 106
LEL = 1 per cent
Solvent coated = 2.61 lb per min

TABLE 2 PROCESS OF SOLVENT EVAPORATION

Time, min	Solvent evaporation temperature Deg F	Deg R	Solvent evaporation Per cent per min	Lb per min
0 to 1	80	540	4	0.1044
1 to 2	80	540	3	0.0783
2 to 3	80	540	3	0.0783
3 to 4	160	620	16	0.4176
4 to 5	160	620	16	0.4176
5 to 6	160	620	13	0.3193
6 to 7	160	620	10	0.2610
7 to 8	300	760	29	0.7569
8 to 9	300	760	6	0.1566
			100	2.61

Calculation of Solvent Evaporation in Cubic Feet per Minute (Cfm):

$$\text{Cfm of solvent} = \text{lb of solvent evaporated per min}$$

$$\times \frac{\text{Cfm per lb-mol at standard conditions}}{\text{Standard molecular weight}}$$

$$\times \frac{\text{Evaporation temperature}}{\text{Standard temperature}}$$

or

$$\text{Cfm} = \text{lb of solvent evaporated per min} \times \frac{359}{106} \times \frac{\text{evap temp}}{492}$$

or

$$\text{Cfm} = \text{lb of solvent evaporated per min} \times 0.007 \times \text{evap temp}$$

Referring to Fig. 5 and Table 2, we can construct Table 3.

TABLE 3

Time, min.	Evaporation temperature, deg R	Solvent evaporation Lb per min		Cu ft per min
0 to 1	540	0.1044		0.3946
1 to 2	540	0.0783		0.2959
2 to 3	540	0.0783		0.2959
3 to 4	620	0.4176		1.8124
4 to 5	620	0.4176	× 0.007 =	1.8124
5 to 6	620	0.3193		1.3857
6 to 7	620	0.2610		1.1327
7 to 8	760	0.7569		4.0267
8 to 9	760	0.1566		0.8331

Calculation of Cubic Feet of Air per Minute (Cfm) Required. The LEL of xylene is 1 per cent. To be safe we choose to operate at 40 per cent of the LEL or

$$40 \text{ per cent of } 1 \text{ per cent} = 0.40 \text{ per cent}$$

or

Air required in cubic feet (cf) at the various exhaust points, shown in Fig. 5,

$$\text{Cfm} = \frac{\text{Solvent evaporated in cf} \times 100}{0.40}$$

Forty per cent of the LEL is considered safe by insurance-company representatives, government officials, and operating engineers. It is an experience figure, and it should not be exceeded. Operation at 40 per cent of LEL results in a safety factor of $2^1/_2$. Practical experience shows this to be safe.

Table 4 shows the values of air required for the different time intervals and at the various exhaust points.

To eliminate explosion hazards it is necessary to exhaust outside of the oven around the coating machine, a minimum

TABLE 4 VALUES OF AIR REQUIRED

Time, min	Solvent evaporation, cfm	Air required, cfm	
0 to 1	0.3946	98.65	(1)
1 to 2	0.2959	73.97	
2 to 3	0.2959	73.97	
3 to 4	1.8124	453.10	(2)
4 to 5	1.8124	453.10	
5 to 6	1.3857	346.42	
6 to 7	1.1327	283.17	
7 to 8	4.0267	1006.67	(3)
8 to 9	0.8331	208.27	

NOTE: Summarizing the air requirements: (1) 246.59 or 250 cfm; (2) 1535.79 or 1600 cfm; (3) 1214.95 or 1250 cfm.

of 250 cfm of air. In the 160 F zone of the oven, an exhaust of minimum 1600 cfm is necessary, and in the 300 F zone 1250 cfm must be exhausted.

HEALTH HAZARDS

When solvents are used for surface coating the machine operator is exposed to health hazards unless solvent vapors are kept under a maximum allowable concentration (MAC). Tables showing maximum allowable concentrations are published by insurance companies and health departments. Table 1 shows the MAC values adopted by the American Conference of Governmental Industrial Hygienists at its 1947 meeting. It is important to give consideration not only to the MAC but also to the time of exposure. Therefore the "toxicity" ventilation rate is based upon an 8-hr daily exposure.

Many solvents are not toxic in the true sense of the word, but they are irritating or narcotic and require ventilation. It is the job of the designing engineer not only to prevent excessive poisoning fume concentrations, but to maintain an atmosphere that is tolerable and satisfactory from the workers' standpoint.

The air requirements in cubic feet per minute (cfm) to eliminate the health hazards is calculated as follows:

$$\text{Cfm} = \frac{\text{Lb of solvent evaporated in 8 hr}}{\text{480 min}} \times \frac{\text{Cf per lb-mol at 492 R}}{\text{Molecular weight}} \times \frac{\text{Room temp in deg R}}{\text{492 R}} \times \frac{\text{1,000,000 parts of air}}{\text{Maximum allowable concentration}}$$

or by combining the constant factors

$$\text{Cfm} = \frac{\text{Lb of solvent in 8 hr}}{\text{Molecular weight}} \times \frac{\text{Room temp in deg R}}{\text{Maximum allowable concentration}} \times \frac{359}{480} \times \frac{10^6}{492}$$

or

$$\text{Cfm} = 1540 \, \frac{\text{S} \times \text{RT}}{\text{MW} \times \text{MAC}}$$

where

S = solvent evaporation, lb per 8 hr
MW = molecular weight of solvent
MAC = maximum allowable concentration, ppm
RT = room temperature, deg R

Applying this formula to our example, Fig. 5, we find that vapors are evaporated in the working area for the first 3 min of the coating process. After this time, the coated material enters the closed curing oven, and health hazards, due to exposure to workers, no longer exist if the oven is operated properly under slight suction to prevent leakage.

TABLE 5 SOLVENT EVAPORATION RATE

Time, min	Solvent evaporation		
	Lb per min		Lb per 8 hr
0–1	0.1044	× 60 × 8 =	50.11
1–2	0.0783		37.58
2–3	0.0783		37.58

To calculate the toxicity ventilation rate, we proceed as before by determining first the solvent evaporation during certain time intervals. Referring to Table 2, we find the values given in Table 5, and from Table 1 we find that the MAC for xylene = 200, and its molecular weight = 106, from which we obtain, assuming room temperature to be 68 F or 560 R

$$\begin{aligned} \text{Cfm} &= 1540 \, \frac{\text{S} \times \text{RT}}{\text{MW} \times \text{MAC}} \\ &= \text{S} \times \frac{1540 \times 560}{106 \times 200} \\ &= \text{S} \times 40.6 \end{aligned}$$

or the results given in Table 6.

TABLE 6 VOLUME OF AIR REQUIRED

Time, min	Volume of air needed, cfm
0–1	50.11 × 40.6 = 2000
1–2	37.58 × 40.6 = 1500
2–3	37.58 × 40.6 = 1500

Referring to Fig. 5, and the final selection of exhaust fans, we find that exhaust fan No. 1 should have a minimum capacity of 250 cfm to keep the solvent concentration below 40 per cent of the lower explosion limit, but it follows also that a much greater fan capacity is needed to prevent the exposure of workers to health hazards. The toxicity ventilation rate in our example calls for the No. 1 fan of minimum 5000 cfm.

For the selection of fans Nos. 2 and 3, only explosion hazards have to be considered since no workers are exposed to vapor concentrations inside of the curing oven. Fan No. 2 should have a minimum capacity of 1600 cfm, while a capacity of 1250 cfm seems to be sufficient for fan No. 3.

PRECAUTIONS FOR SAFETY

In all calculations and in the selection of fans, good judgment and the intelligent use of safety factors must be exercised. It must be realized that occupational illnesses are caused by repeated daily exposure to low concentrations of toxic fumes. These concentrations are often so low that the workers are not aware of their existence.

There are great differences from individual to individual in regard to their vapor absorption. Some can stand higher concentration while others will become ill at concentrations below the maximum allowable value. Therefore it is highly recommended that periodic physical examinations of all workers exposed to toxic materials be made. It is also advisable to make periodic air-sampling tests around coating machines. There are good instruments available which permit

(*Continued on page 149*)

Problems in HIGH-ALTITUDE NUTRITION

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ACCOMMODATION to high altitude has been a serious problem for many centuries, but it has only recently become one of world-wide importance. The conquering armies of Spain encountered this difficulty in the Andes and first wrote about the physiological effects experienced in changing altitude. The subject then lost interest for most of the world because we are predominantly a sea-level civilization. Not until the airplane took man to high altitudes did the problem become an acute one for all nations. Despite this fact, the difficulties faced by armed troops in air movement are really responsible for focusing the attention of the entire world upon this problem. It is one which will stay with us as long as the airplane is a factor in commercial and military activities.

The first accommodation that man is called upon to make in the transition by airplane from sea level to high altitudes is only a speed-up of the processes which took place as the Spanish armies toiled upward in the Andes, and the similar difficulties experienced by a few intrepid mountain climbers. One of the noted first physiological reactions as the mountain climber goes higher in altitude is vomiting. This means a reaction of the digestive tract to change of pressure and lowering of oxygen tension. There are some extreme cases in which men reach a certain definite altitude and cannot pass it regardless of the extent to which they exert themselves, because their digestive systems revolt, and any other activity becomes completely secondary. What takes place in a mountain climber takes place less acutely in the sedentary passenger during quick changes of altitude in an airplane. It is a recognition of these difficulties and methods to combat them which form the subject matter of this paper.

FOOD REQUIREMENTS FOR AIRLINERS

The problem of the service of food on airliners or on any aerial voyage must be considered as one involving the physiological ability of the individual to digest and utilize his food. At times there has been a feeling that at least on the airlines the whole matter might be dismissed. This is only sidestepping the issue. The airlines are specifically used for speed and the type of individual, businessman or otherwise, who saves time this way, plans work for the last available minute on the ground. The result is that, when he gets on board the airplane and relaxes, he remembers for the first time in many hours that he is hungry. The airline as a luxury method of traveling cannot afford to have such an individual remain in that condition. The solution of this problem by the airlines will also be of great value to the military establishment of the country.

The question then narrows down to what types of food are good for such conditions and, conversely, what types of food should be omitted from the menus. In answering this question it will be found that we need not limit ourselves in the slightest in the production of a delicious and nutritious meal. The specifications will still permit many types of food which meet the requirements of luxury travel.

It must be remembered that at high altitudes the low atmospheric pressure leads to a much slower digestive rate. This has been well known for a long time. Therefore the food that is served to the passengers or crew will remain in their stomachs and intestines for a considerably longer time than it would at sea level. Advantage can be taken of this fact, and the meal served can be considerably lighter than would be necessary at sea level, since part of the sensation of hunger is of a physiological nature, induced by an emptiness in the stomach. In brief, therefore, the interval between meals on long flights can be longer than would be possible at sea level, and the amount of food served should be reduced.

FOOD COMPOSITION IN RELATION TO DIGESTION

Now let us consider the matter of the main food constituents, the fats, carbohydrates, and proteins. The ease of digestion of fats depends to a large extent upon the activity of the gall bladder in producing bile. The action of the gall bladder is related to the atmospheric pressure, and, at low pressures, it functions so poorly that the ability of a person to digest fats may be seriously impaired. Therefore the amount of fat present in meals served in the air should be held to a minimum consistent with taste requirements. This does not mean the exclusion of butter or margarine for bread, but fatty soups, rich salad dressings, fatty meats, or ice creams with a very high fat content should be used sparingly, if at all.

The next point of interest is that of carbohydrate metabolism. Because of the greater activity that people are likely to have undergone before embarking on the airplane, there is apt to be a need for a quick energy source. The blood sugar of the individual, on falling to a certain level, will create a demand for replenishment. A beverage, such as sweetened, concentrated, frozen orange juice, will take care of this need on short flights. A cup of coffee with sugar in it would also satisfy this desire, if it were not for the fact that most of the coffee served on the airlines contains some entirely foreign substance which completely spoils its taste and in some cases has actually been known to lead to nausea. On account of the similarity of the taste of coffee on all the commercial airlines, which must be using different types of coffee, the problem may lie in the containers used for keeping it hot. If this can be solved by the use of some good type of coffee (soluble or concentrate), mixed with hot water, it could be used interchangeably with orange juice or similar beverage.

The carbohydrate demand also might be supplied by a higher content of sugar in the chewing gum which is so frequently used on the airlines. In this case, the distribution of the gum would have to be made at the start of the flight as well as at the end, as is now customary. The use of fruits or a blend of fruits to supply the carbohydrate need is also possible. The sugar content, however, in the canned variety of blended fruits should be known before a fruit salad is made. In some cases the sugar content is extremely high and will not meet the requirements of

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the modern woman who watches her calories lest they find their way to her waistline.

In the case of the heavier meal over longer distances of transit, any form of carbohydrate such as rice, potatoes, bread, or spaghetti can be used, but here again it must be remembered that the meal must be kept light as it is going to remain in the stomach a great deal longer than it normally would. To assist the digestion, the particle size of these materials, such as potatoes, should be on the small side. In other words, mashed potatoes are better than whole boiled, and fried potatoes are out on account of their fat content. The cooking of these carbohydrates can become the essential feature of the difference between a good meal in the air and a poor one.

Finally, we come to the proteins which are the building blocks of our physiological system. The proteins of course will supply some of the energy necessary for the human system, but they will be looked upon mostly from the point of view of taste. Of the various meats, beef and lamb seem better suited to airplane food service than the fatter meats, such as pork. The use of fish, high in protein content though it is, does not seem to be wise, because the digestive demands created by many types of fish are more severe than in the case of the common meats. Food idiosyncracies of individuals with regard to fish are far more frequent than those involving meat. The meat section of the meal will take the longest time to digest and, so as not to render a passenger uncomfortable, the meat portion should be small but, again, well-cooked.

PHYSIOLOGICAL AND PSYCHOLOGICAL ASPECTS OF PROBLEMS

In the foregoing, consideration has been given only to service of a complete meal, but it is also implicit in the discussion that a small amount of food at high altitude is physiologically preferable to a large amount. A wise and general use of sandwiches followed by a good beverage or a light dessert like sherbet will fill the physiological and psychological needs of passengers on anything except very long flights. The cuisine of the airlines has to be carefully planned, but more than that it has to be inspired. It is true that the businessmen who fly on these lines are quite frequently the type who frequent the better steak houses, but the physiological changes taking place in them at high altitudes will render their desire for that type of food quite rare. There is a keen blending at high altitudes of both the physiological and psychological needs of the passenger.

Many people will say that the day of the pressurized chamber is so close that the solution of the physiological needs of the passenger in relation to high altitude is unnecessary. This cannot be so, because regardless of how well the mechanical engineers solve the problem of pressure, it will be better to supply the type of meal that could fit the circumstance of damage to the pressure machinery of the airplane. Aside from this will be found the psychological changes which are intrinsic in the problems of swift motion of flight. The digestive system is affected through the sympathetic system, and thus involves the problem of food intake and usage.

CONCLUSION

In closing it would be well to make the point that the meals served to the passengers are also frequently eaten by the crew. The light type of meal suggested is far more in accordance with the physiological needs of the pilot and co-pilot than heavy meals which will lower their reaction time temporarily. It is impossible for a meal to be lodged in the stomach and intestines without having the blood vessels in that region open wide thus changing the relative circulation to the brain and other centers. The sooner these vessels return to normal size and the blood flow returns to the brain and the peripheral system, the sooner the pilot's reactions will become normally sensitive. It is well known that stewardesses notice that quite frequently, after a meal has been served, the passengers in the airplane complain of chilliness. Some of the reason for this complaint lies in the fact that there is not as much blood going to the skin and peripheral organs, and a sensation of chilliness follows. Keen attention to the type of food, both as to content and tastiness, and to the passengers' reaction to various types of food, will lead to greater understanding of food requirements at high altitudes.

Much has to be learned about the combination of foods. Already we know that the proper combination of carbohydrates and proteins produces a higher ceiling in pilots than proteins alone. The use of carbohydrate has been shown to increase the ceiling when used by itself in preflight meals. The concept of the properly balanced meal developed for sea level may not fit the requirements of the man in the air. The man in flight has to be subjected to study just as much as the other parts of the aerial transport system.

Solvent Vapor Control

(*Continued from page 147*)

gas sampling and the determination of vapor concentrations in a practical and simple way.[2]

One safety measure which should not be overlooked, is the introduction of air-flow switches in the exhaust stacks. These air-flow switches are adjustable to a certain air flow, and they can be connected to an alarm or a safety switch which will stop the coating equipment if any change occurs in the amount of exhaust air after the dampers for air flow are once set. The air-flow switch will indicate any change in the exhaust system which may occur due to motor failures on exhaust fans, belt slippage on drives of fans, plugging up of exhaust ducts, incorrect setting of dampers, or an accidental change in damper settings. On very important and expensive equipment, or in factory areas with high occupancy, it may be advisable to have recording or indicating explosion or gas-test instruments permanently installed. It may also be good practice to specify fans made of nonsparking material for any application where explosion hazards are present.

Inside of any drying oven where explosion hazards exist, only explosion-proof switches, explosion-proof lighting fixtures, and explosion-proof motors should be installed. Outside of ovens, where greater quantities of air are moved on account of toxicity hazards, explosion-proof equipment may not be necessary.

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[2] The Mine Safety Appliance Company, Pittsburgh, Pa., and the Davis Emergency Equipment Company, Newark, N. J., for instance, are making gas analyzers and vapor testers practical for factory use.

Opportunities for and Responsibilities to the Young Graduate Engineer in Industry

By LAWRENCE A. APPLEY

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AMERICAN management and its conduct of free enterprise is on trial at the bar of public opinion. Seven years of full employment at rising real wages has set a standard of performance that will not be easy to maintain. Yet if we do not maintain it, the free-enterprise system may not survive. In the final analysis, whether it will or not depends upon the ability of the men who comprise management today and even more particularly, their successors.

IMPORTANCE OF THE ENGINEER'S ROLE

The competence which we can give to the young man today will largely determine the status of industry tomorrow. In this future mold, the young engineer is sure to play a predominant role. It is he who will largely determine the potential "rate of economic progress." When we examine the nature and causes of increasing productivity in the past, it becomes apparent that they can be traced, in great measure, to improvements in technology. The myriad of inventions, methods improvement, materials handling, production planning, work measurement, the application of new knowledge in the most advantageous fashion have, in fact, more largely contributed to rising productivity and increasing standards of living than any other managerial activity. That is the great potential upon which we must draw in the future, which we can use more effectively than we have done in the past through the application of good human relations.

A high level of employment also depends to a considerable extent upon the contribution of the engineers. Employment depends principally upon the level of investment in capital goods, and that in turn is determined by its profitability; that is, upon the difference between receipts and the costs of construction, in which the engineers have a vital determining role. They will have to perform a strategic function in saving the economy during the adverse tides of the business cycle.

Vital is the engineer's role in the sphere of foreign relations. The success of our foreign-aid program will depend to a considerable extent upon the application of American "know-how," the practical restoration of consumption and investment services, the speed with which backward countries can be raised upward. There is also the engineer's role in sustaining and strengthening the armed might of democratic countries all over the world in deadly rivalry with the rising tide of destructive forces beyond the seas.

MANAGEMENT RESPONSIBILITY

These are tasks which can be supported only if management continues to recognize and to fulfill its obligation to the engineering profession. The high standards set by this Society and by others, the sacrifices which each engineer goes through in preparing for a career, in learning for many years, the long hours and sacrifices made by engineers for their profession, these are values which management must support and further, which it must carry on through the rising generation of engineers.

Last, but not least, management owes a deep obligation to the young engineer who entrusts his education, his economic well-being, his status, much of his happiness, and his working life to the company with which he decides to link a large share of his fate. The Christian religion has shown us the value of the life of each individual, how we must nourish, further, and protect it, to permit each to develop himself to the best of his abilities, in an environment of freedom and opportunity.

I cannot emphasize too strongly the gravity and the weight of that responsibility to those young men who are now with you and who may join you in the years to come. Their competence, their happiness, their course of life, lie in large part in your hands. It is nothing short of criminal to permit a young graduate engineer, with the investment, training, development, and potential he represents, to shift for himself without planned guidance and help, in the hope he will absorb or inhale what he needs to know or acquire about assigned work.

What, then, needs to be done toward the successful exercise of these responsibilities? I believe the task is twofold, namely, (1) "education for competence," and (2) "status for satisfaction."

EDUCATION FOR COMPETENCE

In educating for competence, we need to set forth the particular abilities desired in the young engineering manager so that we may establish as well as we can the foundations upon which to carry out our teaching. One of the best attempts which I have seen in this direction is the report of the Basic Course Committee of the Carnegie Institute of Technology, a pioneer and an outstanding attempt in the field of engineering education. This committee, composed of some of the top thinkers in the field, and in consultation with other top men in the profession, devoted much time over the years to evolve these abilities as necessary standards in the education of the engineer manager:

Abilities Required of the Engineer Manager:

1 Ability to learn quickly and effectively, from experience after graduation, to conduct and manage manufacturing, merchandising, or sales in industries which produce "engineering products."

2 Ability to recognize the existence of problems requiring logical application of the "engineering approach" procedure in solving problems.

3 Ability to solve the problem(s), as circumstances demand: (1) instantly, (2) with decision, or (3) with deliberation when the time allows.

4 Ability to devise and develop alternative plans in case of failure of the primary solution of the problem.

5 Ability to execute the planned problems, to check and

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revise estimates pointing toward the more successful solution of further problems of the future.

6 Ability to glean and sift information from others—such information being vital to the solution of the problem, but oftentimes strange and novel to the engineering manager.

7 Ability to organize his own thoughts and ideas and to direct the organization of thoughts and the training of others surrounding him.

8 Ability to utilize the fundamental principles of the basic sciences—Physics, Mathematics, Mechanics, and Chemistry—by applying them to the engineering questions pertinent to the solution of the problem.

9 Ability to further apply the engineering principles derived from utilization of the laws of the basic sciences—ever simplified and stripped of contagious complications—in the successful planning toward execution of the engineering manager's problem.

10 Ability to utilize and perform with the standard engineering handbooks, references, and tables.

11 Ability to establish standards, to judge performance within such standards, and to control such performance.

12 Ability to express himself in oral and written communications—in business, and in the community.

13 Ability to deal with people, businesswise and socially—to make friends and keep them.

14 Ability to engage in any enterprise with a keen analytical sense, a sense of values and time, and a contagious enthusiasm.

The successful development of these abilities can be accomplished in two stages—in college and at work.

College Training in Engineering. Clearly the advice of the engineering profession to colleges and universities is vital in order to accomplish the objectives which have been set forth. Unless there is counsel and consultation, checking and rechecking of the academic program in the light of the standards, the needs and the results actually accomplished, unless there is "cross-fertilization" of these two types of experiences—academic and practical—we shall fall far short of the ideal engineer manager we set up. Yet by and large there seems to be little in the way of the extensive co-operation required.

There are occasional lectures by a professional engineer at the college, some plant visits, some students employed by industry in the summer months, too much dependence upon what the student can pick up; the foreman usually not trained to train the student engineer. Walter P. Schmitter, chief engineer of The Falk Corporation, of Milwaukee, sums up the situation thus: "The data indicate that, except for a few commendable cases, the co-operation of industry with university is but a feeble gesture. We walk our separate paths and nod politely when they cross. . . Probably the fault should be laid at the door of industry."[1]

Two major possibilities appear to be open to industry to improve this state of affairs. More active consultation with colleges may be undertaken to aid in the improvement of college programs. That requires a reconsideration of some of the basic criteria.

Almost 15 years ago Robert Doherty,[2] president of the Carnegie Institute of Technology, outlined one such approach which may hold much promise. It is his feeling that the minds of students are not being prepared properly in independent thinking. They are largely trained to be familiar with certain formulas which they know must be applied in certain cases. Their minds are like cookbooks—if they know where to find the recipe for a certain situation, they can handle it almost mechanically by following conscientiously each step. But they are apt to get lost when they are confronted with a problem which does not conform to certain types, that is, they seem incapable of analyzing problems in terms of general principles.

Hence education in engineering colleges might be turned more in the direction of fundamental principles, in the evolution of which the student should take an active part. The basic principle should also be applied immediately so that it is made useful or is more likely to be retained by the student. As a matter of fact, in the development of course work, the basic principles in each should be stressed, one course should be built upon the other, and all unnecessary matter eliminated.

Another neglected element in the engineer manager's education is his inability to think clearly and be well informed on the humanities—the problems of economics, human relations, and political matters. "Where such a balance has not existed the student's intellect has been literally starved for the vitamins of human appreciation, thus leaving him with what might be called technical rickets—a wooden interest in matters outside his technical field. . ."

Industry Training in Engineering. Next I want to turn to the type of training facilities which might be provided by industry for the engineering student. Intensive education in industry in line with the basic principles I have outlined seems required. Companies might guide engineering students through specially trained engineering advisers, working closely with the students' instructors, such as is being done by the Massachusetts Institute of Technology. The university's engineering staff might spend a part of the summer vacations with their students in surveying the engineering problems of a community or a plant and make recommendations on their findings, as was done most successfully by the School of Engineering of Columbia University in three Connecticut communities. Companies and engineering associations might more widely invite professors to participate in their activities and give them a more practical approach, as well as to benefit from their wide point of view.

For example, the Monsanto Chemical Company has started a program whereby university and college faculty members in chemical engineering can gain a full year's on-the-job experience (at company pay), while the company's engineers may go to the university of their choice for an academic year of study at full pay.

There is one final aspect of training which appears to need careful consideration, that is, the training by the company of the graduate engineer on its staff. Here again, much improvement seems to be needed. The subcommittee of the Engineers Joint Council's Committee on the Economic Status of the Engineer, in a 1946 survey, found that only 50 per cent of the respondents reported that special provision is made for professional development of young engineers in their employ; only one third have a formal training program; university help and guidance appear to be rare. This weakness appears especially in small companies where the opportunities for individualized training seem to be particularly promising.

The engineer spends much time and careful thought to get the maximum production from his machines and to keep them in the best shape as long as possible. Yet when it comes to the training of his successors a poor job seems to be done by many. I would urge that a careful development program in this field is essential, if engineering management is to live up to its professed human obligations, quite apart from the fact that such a program would pay handsome dividends.

Initially this requires careful setting of standards, and selection by the company's engineering staff. The new man needs thorough orientation. Next, a formal training program, developed in line with opportunities, should be set up under the guidance of an engineering counselor, who watches progress and reduces difficulties with supervision and production management. A top-management official's personal interest in the young engineer would be a great additional spur. Regular checks and reorientation of the program in line with needs are required. These formal and systematic training efforts we can neglect only at our peril. For the engineering group generally, outside lecturers, attendance at local colleges and university extension courses, possibly even a shifting of routines and positions within the plant, might be considered to improve competence.

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[1] "Engineering Training," by W. P. Schmitter, MECHANICAL ENGINEERING, vol. 70, September, 1948, pp. 743–749 and 767.

[2] "Readjustment of Policy and Program in Engineering Education," by Robert E. Doherty, *Journal of Engineering Education*, vol. 25, 1934, pp. 26–48.

STATUS FOR SATISFACTION

Sometimes when I study or hear of the status of the engineer in industry, as it is today, I think back to the days of the war when another segment of management, the foreman, unionized in tens of thousands in protest against the neglect of their position. The current concern among engineers, the studies of their economic status by the engineering societies, the use of some professional societies as bargaining agencies for economic improvement, the rise of independent unions of engineers, the pressure by rank-and-file unions—all these are indications that top management should be alert and not relegate the engineer to the stagnant sector of our economy.

To illustrate what I have in mind let me quote an excerpt of a survey made by a young engineer of his own position, and the status of his colleagues in a number of companies, ranging all the way from a low to a very high reputation in the public mind:

"The forgotten man of our aggressive American civilization today is the so-called 'white collar' worker who is neither able to penetrate the lower fringes of management which represents business capital nor fall into the category of tradespeople and production workers as encountered in organized labor. One segment of the forgotten-man section of our society is the graduate engineer.

"The 'average' graduate engineer is unique in his position. He works in an office removed from actual production areas and is generally regarded as part of the higher-ups by both the factory workers and society in general. Yet the engineer is subjugated to every whim and fancy of management. He rarely has the opportunity to be a factor in determining company policies, conditions of work, and rates of pay. His grievances are seldom settled to his satisfaction and he is open to the threat of discharge and black-list if he undertakes to better his position as an individual. Yet it is the engineer's own fault that such a condition exists. He is afraid, afraid of losing his livelihood in a field for which he has trained for years and which at last is beginning to reward him with an income and maybe a paternalistic security as offered by some companies.

"Out of many discussions, a conclusion was drawn that for the average engineer to obtain the best possible position in his profession until the day when a 'John L. Lewis' shall appear upon the scene and deliver his fellow engineers from the clutches of a static environment, he should try to gain employment with a firm that would offer him the best possible advantages. It must be understood that such positions do not grow on trees, but are found by a careful investigation after which a diligent campaign to be employed by the concern must be conducted."

The conclusion of this student is that he will try to get a position with a company that has a tested program of meeting his objectives. Companies without such a program may at best lose the chance of hiring outstanding young engineers; in some instances they may even face the threat of some kind of bargaining by groups of their engineers.

What then are the objectives of the young engineer? What are the economic opportunities which he seeks, the complaints he has voiced against their lack, and the possibilities of adjustment by management?

Adequate Compensation. The young engineer wants adequate and fair pay. There have been many complaints on this score—low starting salaries, slow rises, inadequate remuneration considering professional status and the length of preparation required, inadequate differentials compared with unionized hourly rated employees, too big a spread between the engineer and his superior, between the "mass" of engineers and the exceptional engineer. Particular grievances have arisen from companies' patent policies on the score of inadequate recognition.

A satisfactory pay policy would seem to call for starting pay and base pay in line with recommendations of the professional societies, adequate to take account of the length of training and the requirements of the engineer's status. It is evident that such a pay policy can be accomplished equitably only by a good job-evaluation plan, constantly kept up to date.

An important element of the engineer's pay should include "fringe benefits" in the form of proper vacation pay, insurance benefits for sickness, accidents, old age, and death, occasional leaves of absence. Careful consideration needs to be given to incentives. An annual bonus might be paid for good performance, a special bonus for special accomplishments.

Companies might also consider a more liberal patent policy. Groups and individual engineers might put forth special effort, if some kind of recognition were provided by the company, such as perhaps a bonus.

A Responsible Job. Most people want to do a job which utilizes their capacities to the utmost. Yet at times engineers are put into routine jobs which could be performed equally well by persons with a less specialized education. Another frequently mentioned barrier is advancement, the lack of it or the haphazardness of the procedure. Finally, much ill-feeling is aroused by the practice of having research-minded engineers report to production-minded executives who expect results daily.

Many of these difficulties might be alleviated by a system of "management alignment," under which engineers would be allocated proper managerial functions, corresponding to their capacities. The feeling of being "buried in oblivion" could be avoided by a "personnel inventory" which describes the nature of the job, the responsibilities of the individual, his performance, his potential, and a regular follow-up by members of higher management.

The training efforts which I have mentioned are of course of great importance. The supervision of the engineer might be placed more advantageously into the hands of men who are familiar with the nature of their needs and who can act as a sort of protection against those overly concerned with immediate results.

Recognition and Prestige. Recognition and prestige are of course especially important for any professional and often serve as a compensation for disadvantages which may be attached to that position.

This objective requires a particular interest by higher management in the work of the engineer and an expression of real appreciation. The engineer even more than other employees resents being a number or one of many.

(Continued on page 165)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Attending Meetings

AN interesting and enlightening article, "On How to Attend an AIME Meeting," by E. H. Rose, Tennessee Coal, Iron, and Railroad Co., appears in the January, 1949, issues of *Mining Engineering, The Journal of Metals,* and *Journal of Petroleum Technology*. While written for AIME members, the thoughts prescribed in the article can be applied equally well to members of ASME.

The article points out that the complaint is often heard that members cannot justify the time and expense required to attend an Annual Meeting. Almost invariably, the reason given takes this form: "I just don't see that I would get enough out of it." Often the would-be clincher is added: "Besides, the meat of it all comes out in print anyway."

It is in agreement that anyone holding such a belief indicates by his first remark that he does not know how to attend a convention, and by his second, proves it. He is, by and large, the man who has never been there, and of him, there are many. Since he must often justify an expense account, these remarks are addressed to his employer as well.

Much can be gained by attending an engineering meeting, according to the article. A few items are as follows:

1 *Information picked up in person-to-person contacts bulks far larger in take-home pay-off than the official fare.* The formal presentations necessarily are contributions to knowledge in the broad sense. They deal with the contributor's experience, not the listener's. They are a one-way conversation, so to speak. The listener takes no really active part, other than discussion from the floor and that only after the speaker has had his uninterrupted say. There is no give and take concurrent with the presentation, and afterward it is too late for the knocking about of points of detail, even if time permitted, which it never does, and even if the listeners did not self-consciously "freeze" as they attempt their remarks from the floor, which many of them do.

But in the corridors, it's different. There and in the uninhibited informality of private rooms, where kindred spirits foregather, you find the source of the kind of information you came to get—the details too small or specialized to come out in the necessarily condensed formal sessions, the latest on-the-scene accounts of experiments known to be in progress but not yet advanced enough for formal reporting, the stories of experiments that failed and hence were not published to warn others away from the same blind alley, and the innumerable straws in the wind to indicate the direction of technological progress to come. There you do not take larger topics, one at a time, and exhaust them before passing on to the next. There you really get down to cases.

Little stuff perhaps, but of good assay, and sometimes a real nugget turns up. One such item reduced to practice back home for a saving of a picayune twenty dollars a month would pay for the annual trip to the meeting, even if the member came from the other side of the continent. It is, indeed, the reason many show up year after year—without insurance other than their own convictions built up out of experience.

Nor is it all little stuff, states Mr. Rose. He cites two major changes of practice in large plants that came about five years sooner than they would otherwise have as the result of just such conversations in the byways of Annual Meetings—and no confidence violated in the process.

2 *Repeated attendance pays increasing dividends.* Implicit in the foregoing is acquaintance with those persons of the most relevant interests, and the degree of mutual benefit is measurable by the degree of mutual friendship, understanding, and respect. The standoffishness of strangers is fatal; the camaraderie of old friends, perhaps not seen since the preceding meeting, is the instantaneous catalyst that induces the real reaction of minds, and the real yield of profitable guidance on both sides. He would be a backward soul, indeed, who, after the first year or two, could come away from any Annual Meeting without at least a dozen new first-name friends, to push his circle of provincialism correspondingly outward. Attending regularly, his contacts, instead of becoming so broad he cannot cope with them, become the more selective and fruitful.

3 *Reciprocity is essential.* In addition to attendance, participation in the organization's activities is the key that opens the door to the benefits sought, Mr. Rose points out.

Many inactive members sincerely believe that they are not qualified to write papers, for lack of either material or talent.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

Often that may indeed be true but it does not follow that they are unqualified to pursue other activities such as serving on national or Local Section committees, all of which is as voluntary as the writing of papers and even more rewarding. Someone may say that he has never been "put" on a committee. The process is not quite so passive; one has first to open his eyes to the many ways in which he could be useful to others and thus in due process to himself and to his employer. To be selected, he must become visible. A few thoughtful letters written to the chairmen of committees covering his field of work or his geographic area—making suggestions, offering criticisms, or even merely asking the questions he asks himself verbally—and he will soon find himself out on the main line moving with traffic. He can be perfectly selfish about it, not for a moment pretending that such activity on his part is out of the kindness of his heart or for love of his fellow man, but strictly on the basis that such is directly or indirectly a sound currency of trade for any of the desirable objectives: professional recognition, technological information, a promotion, or a different job. It just happens to work that way, as many can attest. Even on a committee, there will be no one standing at his elbow telling him what to do. It is his in-time-well-rewarded job to think of something to do. He must contribute information as well as seek it.

Stream-Pollution Control

FEDERAL control of stream pollution has been approved by Congress, after 50 years of controversy according to the *Industrial Bulletin* of Arthur D. Little, Inc., October, 1948. Under the new Barkley-Taft Water Pollution Control Act, the Public Health Service will survey U. S. rivers and streams, and polluters may be forced to clean up their discharged wastes. If corrective measures are not taken, the federal government, with the approval of the state, may sue non-co-operators.

Funds will support the Public Health Service and Federal Works Agency programs, as well as investigations and some corrective construction. A million dollars a year will be available as grants to states, cities, and other public agencies for engineering and economic investigations. During each of the next five years, funds may also be loaned to assist public agencies in building control facilities to prevent untreated sewage from entering waterways. The states will also co-operate in more fundamental research, and another million dollars annually may be used for subsidiary investigations.

The new legislation alleviates somewhat the economic problem by making loans available to state and local government, who in turn are to assist industry. These loans are made through the Federal Works Agency, with the approval of the state water pollution agency and the Surgeon General. The maximum loan is either $250,000, or one third the estimated cost of the project, whichever is less.

No standard procedures are available for purging most of the endless combinations of wastes that arise in industry, and most research must be "tailor-made" for individual plants. For each plant, it is desirable to survey the various sources of waste and to develop a comprehensive plan for dealing with all. This plan and treatment facilities, however, should be flexible enough to provide for future process changes with consequent changes in the waste. A leading objective of research should always be the development of generally applicable procedures, but usually it is necessary in practice to deal with the individual constituents of the waste, rather than simply with "oxygen demand." This is a common measure of pollution and refers to the extent to which oxygen is removed from the stream by the waste, with consequent injury to fish life. A recent survey reveals that the Public Health Service estimates that an investment of about $8 billion will be necessary for water supplies, sewerage, garbage and refuse disposal, and rural sanitation, without including treatment of industrial waste. That industry will have to spend a comparable amount can be predicted from the program of the synthetic rubber industry, which spent nearly $14 million during the war to treat waste from various plants.

Such huge investments for treating plants are in the long run often inexpensive, or even profitable, since valuable by-products may be salvaged from treated wastes. For example, cheap contact sulphuric acid from nonferrous metal smelters may be recovered instead of going into streams, and phenol from material formerly wasted finds a ready market in the plastics industry.

Prior to the war several rayon plants installed treatment facilities for their waste spinning liquor. The principal product of this process was salt cake, a cheap heavy chemical obtained in large quantity from Europe. When the war cut off the supply, the rayon manufacturers were able to dispose of all the material they could recover. Even today, salt cake is scarce and sells for about $25 a ton. Two rayon companies are at present recovering about 150,000 tons of salt cake annually.

The Atomic Energy Commission is conducting an extensive study of the problems of getting rid of radioactive waste, and the results may be of general interest to industry. Whether it is profitable or not, industry and local governments are going to get busy on the world's largest project for control of stream pollution to protect one of our most important natural resources.

Uranium Supplies

DURING a recent press conference held in Denver, Colo., David E. Lilienthal, chairman, U. S. Atomic Energy Commission discussed the statements that have been made and widely publicized, that there is only enough uranium ore to last a relatively brief period, and so the prospects of benefit from atomic power must go glimmering. He emphasized that this is simply not so. It appears clear that atomic energy is on a sound basis for an indefinite period in the future.

Mr. Lilienthal said that an unwarranted impression that a shortage of uranium will drastically limit the possibilities of atomic energy has been caused by estimates that known reserves of uranium would last perhaps only 30 years or not more than 40. Estimates of the total world supply of uranium have run from 30,000 tons to 500,000 tons, seventeen times as much. Estimates of rates of potential consumption of the fissionable material derived from uranium have also varied considerably, he stated.

As explicitly as national security permits, the Atomic Energy Commission wishes to state that it finds no basis in fact for these statements about extremely limited uranium ore supplies. If this shortening of the atomic age were accurate, the plants and operations of the atomic-energy program of the United States would have to close up in a few years.

Instead, the contrary is true about uranium supplies, he said. Estimated known reserves have already increased substantially since usefulness of uranium as a source of fissionable material became firmly established.

He pointed out that before the war, uranium was used principally as a pigment in the ceramics industry and was essentially a by-product of radium or vanadium ore. Man has just begun to look for uranium; in every quarter of the earth's surface prospectors' picks are breaking the rocks in this search.

The current great prospecting surge may result in the discovery of new uranium deposits that will significantly alter our concept of world supply. Some good prospects are turning up in Canada, to cite only one country. It would be surprising if new discoveries there would not over the years equal or better the great Eldorado mine, he stated. Only a few new important discoveries would change the world-supply picture profoundly.

One of the rules of mining is to look for new ore deposits close to known big ones. New discoveries in the Eldorado mine or Shinkolobwe mine in the Belgian Congo would affect the uranium-supply position of the world as profoundly as, say, one in South America—and would be reflected in production sooner.

One factor that obviously has not been taken into account in these pessimistic predictions about the uranium-ore supply is our growing technology and its future application to low-grade sources of uranium, he stated. Most metals have gone, or are going through a cycle where high-grade deposits are at first the only commercial deposits. Then gradually large low-grade deposits yield to man's technical ingenuity and become important producers.

According to Mr. Lilienthal, plans to recover uranium from oil shales and other types of marine sediments which contain small amounts of uranium are under study in this country as in other parts of the world. One important potential low-grade source is that announced recently by the Union of South Africa. The gold ores of the Witwatersrand contain low concentrations of uranium, and by-product uranium undoubtedly will come from the huge gold-mining industry of that country.

Uranium has been estimated to occur in the crust of the earth probably a thousand times as plentifully as gold or a hundred times as plentifully as silver, and possibly more plentifully than lead or zinc. Figures of this kind, however, have even less meaning than figures for proved ore reserves, he pointed out. It takes considerable concentration of uranium, just as it does of lead or zinc, to make a mineable deposit under anything like present economic conditions. The fact, however, that uranium is not a great rarity lends credence to a geological opinion that it is apt to be present in the right place reasonably often when geological concentrating processes are at work.

The Atomic Energy Commission of the United States is responsible for one of the most extensive and intensive searches for a mineral that has ever been conducted, and on a world-wide basis. He said that we do not expect that there will be an unlimited supply but there is no sound basis for a conclusion that usable uranium ore supplies will not be available for the indefinite future.

Specifically, uranium comprises about 0.0004 per cent of the earth's crust, but it occurs sparingly in significant concentrations. A summary prepared by the U. S. Atomic Energy Commission points out that there are five major classes of uranium deposits which are being exploited now or will be exploited in the future:

1 High-grade pitchblende-radium deposits (assaying better than 1 per cent uranium oxide [U_3O_8] in quantity worth mining) occurring as replacement bodies. Where oxidized, the ore consists of autunite, carnotite, and other oxidation products of pitchblende, many of which are brightly colored. The better-known deposits of this kind are Eldorado in Canada; Shinkolobwe in the Belgian Congo (from both of which the United States obtains uranium); and Joachimstahl and other deposits in the Erzgebirge district of Czechoslovakia and Germany which, according to newspaper accounts, Russia is exploiting. Deposits of this class may contain appreciable quantities of silver, copper, or cobalt.

2 Carnotite-type and roscoelite-type vanadium-uranium ores of the Colorado Plateau. These closely related ore types are apparently important only in this country, but at best they are quite inferior to the high-grade ores as a source of uranium. These deposits occurring in flat-lying sandstones are under active development as part of the Commission's program. Ore acceptable at AEC ore purchase depots contains a minimum of 0.1 per cent U_3O_8, and payment is made for vanadium (V_2O_5) content in a ratio not exceeding 10 parts V_2O_5 to one part U_3O_8. By-product uranium from privately-owned vanadium plants is also purchased by the Commission.

3 Gold-uranium ores of the Witwatersrand, South Africa. Public announcement has been made of the occurrence of uranium as a very minor constituent of the gold-bearing Witwatersrand conglomerate. The prospect exists of future by-product uranium from the great gold-mining industry of the Union of South Africa. The Commission, through the U. S. Geological Survey, has been systematically examining all of the mill and smelter products in this country to discover if similar by-product possibilities exist here.

4 Uranium-bearing oil shales and other marine sediments. It has long been known that certain oil shales and other marine sediments, including phosphatic beds, contain very small quantities of uranium. Sweden, for example, has announced that she is building a small atomic pile and intends to derive uranium from her oil shales to feed this pile. According to published statements Swedish shale deposits containing many millions of tons of "ore" run around 0.02 per cent U_3O_8. (These same geological formations extend northeastward up through Estonia and Leningrad.) By-product uranium from oil-shale or phosphate industries may play a part in the development of atomic energy in different parts of the world. The AEC expects to exhaust every possibility of this character in the United States.

5 Miscellaneous other deposits. Pegmatites containing small amounts of pitchblende, placers containing a little uranium (generally as thorianite) along with monazite, and other ore types of as yet minor importance.

Vertical Wind Tunnel

THE 12-ft vertical wind tunnel at Wright-Patterson Air Force Base, Dayton, Ohio, is now in full operation, according to the CADO *Technical Data Digest* for December 1, 1948. This facility has a wider range of velocity than any other wind tunnel of the vertical type. It also includes several unusual design characteristics which should enable it to further contribute in the saving of human lives, time, and experience in the advancement of aeronautical research and development.

Project engineers use this wind tunnel primarily to study stability spin and recovery characteristics of aircraft; however, many other research and development projects will come under its scope. Current programs have included investigation of open shock and stability of parachutes, cockpit canopies, design, pilot-ejection seats, study, autorotation problems of rotor blades for rotary-wing aircraft, and various free-fall projects.

Testing technique in a vertical wind tunnel differs essentially from the conventional horizontal-type wind tunnels in that the subject models are not mounted on wires or struts to any balance system, but are actually able to fly free.

The entire structure of the wind tunnel is made of concrete with cylindrical walls of thin reinforced concrete that are in two sections. Inside is a smaller cylinder through which the air stream flows in an upward direction. Midway up this inner cylinder is the test chamber which is 12 ft in diameter. A 16-

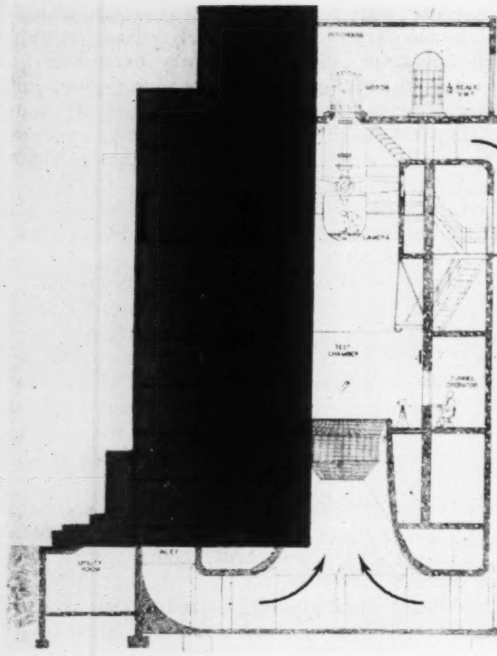

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FIG. 1 VERTICAL WIND TUNNEL

ft, controllable-pitch, four-bladed wood fan mounted directly above the test section draws the air stream upward. It is then diffused into the return flow passage between the inner and outer walls and returns again through the testing area. This is a closed-circuit atmospheric-type wind tunnel. Continuous operations with 900 hp can be maintained using a d-c synchronous motor with a Ward Leonard type speed-control system. With the fan in the maximum pitch, setting velocities above 150 fps are possible.

Dynamic scale models of aircraft used in the studies are usually constructed in the AMC Engineering Shops Laboratory. The controlling surfaces of these models are operated by a small magnetic mechanism installed within the model. This mechanism is actuated by a magnetic field created by 12 copper bands encircling the test-chamber wall. When a model is to be tested it is manually launched into the air stream and is suspended by equalizing the air stream to support the weight of the model. The models are between 20 and 30 in. in span and weigh about three pounds. Two instrument panels, one inside the test chamber and one outside, control the air-stream velocity and also actuate the magnetic field; however, only one instrument or control panel is used at a time.

Motion pictures record the model's flight while in the air stream. This information, together with data taken by observing wind-tunnel personnel, is used as a direct aid in determining what the spin and recovery characteristics will be. From the results it is possible to recommend to the manufacturer modifications to the design or loading conditions of the aircraft which will improve spin and recovery characteristics.

The cameraman is housed under a glass dome just below the fan, and is protected by a net which keeps the test model from hitting either the dome or the fan.

Scale-model parachutes are investigated in basically the same manner as the model planes in the vertical wind tunnel. Testing a model of a parachute of radical design saves much time and equipment when this is accomplished prior to fabrication and flight-testing of a full-size parachute.

Further modifications of the vertical wind tunnel are in progress, in addition to the development of testing techniques which will permit more advanced investigations in the future.

Plastics and Wood

IN an address given by William T. Cruse, executive vice-president of The Society of the Plastics Industry, before a meeting of the Forest Products Research Society in New York, N. Y., recently, he pointed out that there are two aspects of the relationship of plastics to wood. First, their use in combination with wood, where they are employed as adhesives, and second, their use in mechanical combination with wood.

The development of adhesives until recent years is largely the history of animal glues and their applications, Mr. Cruse said. Egyptian murals and veneered caskets indicate the early origin of the art of gluing. It is safe to assume that the Egyptians acquired this art from earlier races, applied the knowledge, and carried it on. The first commercial glue plant was founded in Holland in 1690, and the first glue factory in the United States was established in Boston in 1808. Up until this century, the majority of glue applications were in the manufacture of furniture. Synthetic adhesives made their debut about 1928. While much had been done prior to this time in the chemistry of these materials, it was not until this period that they came to be used commercially. It was the need for adhesives which would withstand outdoor exposure and tropical and subtropical environment that led to the development of adhesives that would withstand these conditions.

The types of resinous adhesives which are now extensively used are phenolic, urea, melamine, and resorcin resins.

Phenolic resin adhesives are used principally for making assemblies in wood, plywood, laminated wood, phenol fiber laminates, and phenol paper laminates. They have a curing range from 24 hr at 90 F to 2 hr at 160 F. The allowable assembly time is comparatively long—$^1/_2$ to 2 hr. Water resistance is maximum and bond strength is comparatively unaffected by boiling water as well as cold water. These resins also retard the burning of wood. Their chemical resistance is also greater than wood and they are resistant to attack by microorganisms, such as mold and fungi. This class of adhesive is the one which initially made plywood suitable for outdoor use.

Urea resin adhesives are used largely for making assemblies in wood and plywood, although their use in gluing paper and fabrics to each other and to wood is growing. They have a setting range from 4 to 8 hr at 70 F to 75 F, 1 to 2 hr at 120 F, and 10 to 20 min at 160 F. The allowable assembly time is 15 to 20 min. They have fair water resistance as they withstand fairly long exposure to cold water, but are not resistant to water at elevated temperatures or suitable for continuous immersion. They will not meet the more rigid specifications on water resistance. Heat resistance is good up to 150 F, and chemical resistance is better than wood. They are resistant to attack by mold and fungi.

Melamine resins have been developed for use under general assembly gluing conditions to be set at temperatures not below 110 F. In general handling properties, the melamine resins approach the ureas. They provide, however, a superior resistance to exposure and such testing procedures as boiling water immersion.

They are used principally for wood, plywood, and laminated wood assembly gluing. Some of the more promising so-called gap-filling adhesives come from this class.

The resorcin resin adhesives are a relatively new development but accumulated test data over the last four years indicate that when properly cured at room temperature, they are fully as durable as the phenolic resins when hot-pressed. These adhesives may be cured in from 8 to 10 hr at 70 F to as little as 4 to 7 min at 180 F.

One of the most outstanding characteristics of the resorcin resins is their completely neutral formulation which avoids all damage to the cellulosic fibers. Another valuable property of the resorcin adhesives is their long storage life inasmuch as they are not reactive until the hardener is added.

Combinations of certain of these resins have given desirable results. Melamine-urea is practical because of its economy and efficiency.

Resorcinol is a relatively costly raw material. When used in combination with phenol, it is more economical and the major desirable properties of the straight resorcin resin have been preserved.

Promising development is progressing in the use of furfurol, synthetic protein, emulsion polymers, elastomers, polyesters, and thermoplastic polymer fields, according to Mr. Cruse.

Forty per cent of the Douglas fir plywood is now being manufactured with phenolic-type adhesives. Forty to 80 per cent of the hardwood plywood is made with synthetic adhesives. Mr. Cruse forecasts that the trend to using synthetic adhesives should continue. Since the properties of all classes of plywood are improved through the use of synthetic adhesives, the applications for these materials should be broadened.

The advanced furniture maker is employing glues of the synthetic type. According to Mr. Cruse the furniture made from synthetic adhesives is superior. Competitive influences in time will cause furniture makers to use synthetic adhesives more extensively.

Decorative laminates have proved their worth in the construction and furniture field. Their use in both should continue to expand Mr. Cruse stated.

Extruded plastics made their bow about ten years ago when metal became short early in the war builders turned to extruded plastics for trim. Extruded plastics have continued to enjoy some of this business. The advances that are being made in the art with the use of more suitable plastics and numerous and varied shapes should encourage their wider use in building.

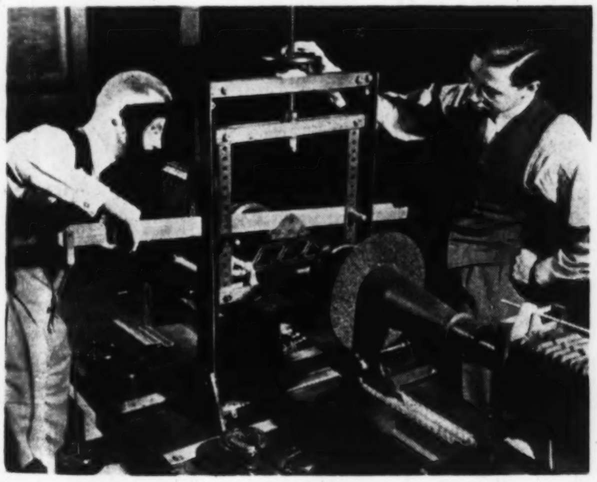


FIG. 2 CIVIL ENGINEERS TEST PLASTIC TRUSS MODEL

(Graduate students in the photoelasticity laboratory at New York University College of Engineering adjust a loading frame in preparation for a test on a model bridge truss. This is part of graduate research in civil engineering covering techniques used to determine stresses and strains in various parts of the structures. Operator at left is manipulating the loading arm which applies force to the plastic truss model shown in the center of the photograph. Polarized light passes through the truss and a camera records the color pattern from which stresses in truss members are calculated.)

Mr. Cruse reported that a type of upholstery which the plastics industry has recently developed is made of a woven extruded monofilament. The plastic employed is vinylidene chloride. It is said to have remarkable wearing qualities. Since the material is chemically inert, it can be washed with soap and water or cleaning fluids and it will not stain. It will outwear any cloth.

Since the war, vinyl plastic "leathers" have been introduced on a large-scale commercial basis. These materials are made of either unsupported vinyl sheets or of supported film. These plastics will neither fade nor stain. They are easily cleaned. When well made, it is claimed that they will outwear leather. Their use as upholstery materials is constantly increasing.

Since the plastics industry spends a sizable percentage of its income for research, undoubtedly more materials, improvements in existing ones, and new products will be developed that will work well with wood in one way or another. The plastics industry is a silent partner of the wood industry, having a vital interest in its destiny.

Xerography

A NEW dry process for printing, reproduction, and picture-taking which the inventors hope will become the fourth major printing process, is described in *Chemical Engineering Progress* for November, 1948. The new method was announced jointly by Battelle Memorial Institute, Columbus, Ohio, and The Haloid Company, Rochester, N. Y. The new technique called "xerography" (from the Greek "xeros" meaning "dry" and "graphos" meaning "writing") uses electrostatic principles for reproduction of images.

According to the article, a picture was taken of a subject and a finished print was made in 50 sec. The final copy may be made on any substance whatever, and instead of an ink, a thermoplastic is used.

The nucleus of the xerographic process is a photoconductive plate. This plate consists of an electrically conductive material, such as a metal sheet, which is covered on one side by vacuum distillation and condensation, with a photoconductive insulating material. This coating is a nonconductor of electricity in the dark but is conductive when exposed to visible light. The most familiar material which exhibits this property is selenium. Anthracene is another substance that may be used but The Haloid Company stated that more sensitive formulas have been developed.

The sensitized plate is passed through a "corona spray apparatus." The object is to spray electrons from a fine wire to the covered face of the plate as it passes evenly on a carrier belt. The electron treatment creates an electrostatic charge and in this condition the plate is sensitive to light. The sensitized plate is exposed in a camera or placed in a contact printing frame. Wherever light strikes the plate, the coating becomes conductive and discharges the electrostatic surface charge into the backing metal. On the places where light does not fall, the surface charge remains. Thus the image pattern causes the latent electrical image to remain in the plate.

To develop the image, the plate is placed in a tray and special powder is poured over it. The powder is made of two components, one a coarse carrier material, and the other a fine developing resin. The powder is attracted to the charged portions of the plate, but the light-affected portions of the plate are unable to retain the powder and it rolls off. The result is a mirror image of the original copy.

In the next step a piece of paper is placed over the powdered plate and the two are passed under the "corona discharge." The powder particles are then attracted to the charged paper. By this transfer the image is restored to its true left-hand relationship. The paper is then placed in a heated press and held for a few seconds. Heat melts the powder granules and fuses them to the paper. This print is permanent and does not rub off and the heating can be done with infrared lamps, electric ovens, or heated platens.

The color of the print depends upon the color of the resin used and it is stated that multicolor prints can be made by combination printing using separate plates for each color.

Almost any material could receive the imprint; cloth, paper, metal, or ceramic may be used and the powders used in the process may be asphaltous or synthetic resins having low melting points.

Balloon Altitude Record

ESTABLISHMENT of a balloon altitude record of 140,000 ft—20,000 ft higher than the previous maximum—was claimed recently by the U. S. Army Signal Corps.

The record was set by a specially built balloon flown by Evans Signal Laboratory, Belmar, N. J., in weather-forecasting and rocket-launching experiments. The Signal Corps designs meteorological equipment for the Army and Air Force, and pioneered in weather forecasting.

To reach the 140,000-ft mark, the record-setting balloon spent two and a half hours rising above the earth.

Extremely high altitudes such as are now being attained by the Signal Corps scientists are almost invariably computed from measurements of pressure. Difficulty in obtaining accurate pressure measurements above 100,000 ft, it was explained, introduces many problems in altitude computation. Special equipment has been developed by the Signal Corps to effect this measurement at acceptable accuracies.

The record-breaking balloon is made of neoprene latex and is approximately 17 ft in diameter at the time of release. It is only partially inflated when it leaves the ground and first becomes spherical at an altitude of about 35,000 ft.

The balloon expands as it continues its ascent, reaching a maximum diameter of approximately 75 ft when it bursts.

The Signal Corps is using high-altitude balloons to carry delicate scientific instruments aloft in an investigation of the physical properties of the atmosphere in the relatively unexplored region between 100,000 and 150,000 ft. Better weather forecasting may be only one of the benefits resulting from the experiments. In addition, the data obtained will be used in connection with the launching of rockets.

Ramjet-Engine Tests

THE longest flights ever made by pilotless aircraft powered with ramjet engines were announced recently by the U. S. Navy and The Glenn L. Martin Company which built them.

The almost wingless missiles are PTV-N-2's (Gorgon IV), and have made several sustained controlled flights of more than ten minutes. Free flight was obtained by launching from a mother airplane and flight information was telemetered back to a ground receiving station by an electronic "brain."

The majority of the flights were made at the Point Mugu, Calif., Naval Air Missile Testing Center. The tests were conducted at subsonic velocities purely to obtain ramjet-engine performance information during controlled free flight.

The Gorgon IV is a high-winged monoplane, 22 ft in length, with a wing span of 10 ft. It is of all-metal construction. Gross weight of the vehicle is 1600 lb, 700 lb of which is ordinary 80-octane gasoline (116 gal), the ramjet fuel. After the initial ignition of this fuel by the spark plug, the burning and thrust are continuous until the fuel is exhausted.

The ramjet on the Gorgon IV is suspended below the fuselage almost at the tail of the bird; it is 7 ft long and 20 in. in diameter at the widest point.

The bird is controlled in flight from a ground station but is may be preset to perform normal flying functions such as level flight, dives, banks, and turns—but not to do stunts. Radar it used to follow the flight path from a ground station. The Gorgon IV is equipped with conventional rudder and elevator, but uses spoiler ailerons for lateral control.

The Gorgon IV is completely instrumented to telemeter to a ground receiving station such data as speed, altitude, brake drag, controllability, engine operation, and other vital information. The telemetering system proved to be extremely reliable and much data for further evaluation of the ramjet was recorded during the flights.

Equipped with a parachute recovery system which operates automatically upon cessation of powered flight, several of the Gorgons were recovered with so little damage that only a minimum of work would be required to prepare them for further flight.

Recovery of the birds was desirable so that further study could be made after landing, in addition to the possible re-use of a "save." No structural failure was reported from the recovered Gorgons.

Reptile Leathers

MORE than a million snakeskins were made into leather in American tanneries last year. In addition, hundreds of thousands of skins from other reptiles—chiefly lizards and alligators—were processed in the nation's tanyards during the year, an article in the *Rohm & Haas Reporter*, November, 1948, reveals.

A large portion of this reptile leather was made in a rather unique tanning establishment, the Goldsmith Leather Company, Newark, N. J., according to the article.

Snakeskin leather, in large measure, is a development of recent years. Alligator leather was being made in a number of tanneries, and a little lizard leather was on the market, but for the most part the processing of anything smaller than alligator and crocodile skins was considered impractical. Snakeskins were thought by most tanners to be too small to handle economically and too tricky to process successfully as a regular production item.

However, by combining research with processing, enough knowledge was obtained about how to tan these long narrow strips of skin.

The basic processing operations at Goldsmith's—liming, bating, tanning, fat-liquoring, finishing, and the like—are the same as are found in any tannery, but they differ in application.

It has been found that making leather out of snake and lizard skins is a specialized trade calling for processing methods not found in other tanneries.

The reptile must be skinned and dried soon after it is killed, or the skin will be of little value.

The skins may reach the tannery as "flint dries," "green salted," or "mud-packed." Flint-dry skins have been stretched out in the air until dry. Cured in this way they are rigid as thin boards. Among these are karungs from the Dutch East Indies, ermines from French Indo-China, tejus and iguanas from Brazil, boa constrictors from Argentine, and diamond-backed pythons from India.

Green salted skins come packed in salt and are not quite as hard as the flint-dry type. Typical are chameleons from Colombia and alligators from Brazil.

Mud-packed skins are coated with a special salty clay mud and packed in barrels. The mud and salt together serve to prevent putrefaction. Skins from Bengal and Agra Provinces of India commonly come in this way. To get at the encased stock it is necessary to break open the barrels and crack the big clay cake up into smaller chunks. Water is then used to soften the clay so that the skins may be removed.

Liming is important in the reptile-leather tannery just as in other leather-making plants. The reptile skin has an outside layer of keratinlike material which must be separated from the collagen (or leather-forming portion) before tanning can proceed properly. This undesirable surface layer covers even the scales of the snake and the hard blocks of the alligator skin. Soaking in the lime vats—usually for a week or two—loosens the coating and permits it to float off.

After liming, the skins are bated with Rohm & Haas Oropon. The enzyme bate removes undesirable protein materials from the skins without causing undue loss of true leather-making substance. After bating a few hours to overnight, the skins are in a loose, flaccid, open condition, ready for the action of tanning agents.

An alligator skin needs from 2 to 4 months in the tanning vats, and snake and lizard skins take at least half that time. This slow tanning is necessary because only paddle or vat tanning methods can be employed.

Snakeskins, during processing, have a pronounced tendency to curl back to their original tubular shape. This makes it necessary to handle them one by one as they are dropped into the tanning vat. They are opened out and flattened by hand as they are put in place in the tannage.

The particular tannage selected for processing the skins depends on many factors. Reptile leather is commonly considered a specialty material and it is important that the tanning process produce a leather that can be finished to conform with changing styles.

Reptile skins cannot be sliced into layers on splitting knives as cowhides or sheepskins are split, but it is often desirable to reduce the thickness of the skins after tanning before the final processing is completed. This is done by cutting off the unwanted material with a shaving knife. It is a hand operation, done on a beam, and closely resembles hand fleshing of other hides.

In most cases, the natural markings of reptile skins are featured regardless of the sort of finish applied. The tanning process must accentuate this natural design. Sometimes it is necessary to eliminate a portion of the natural pigmentation of the skin to achieve the desired result. A special technique makes it possible to bleach out the dark pigment from the skin beneath the scales without destroying the coloring of the scales themselves. In this way the natural marking on the scales is made to stand out and an unusually beautiful piece of leather results.

Depending on the effect desired, either mineral or vegetable tan liquors may be used; or the skin may be tanned in one type of tannage and retanned in the other. Leukanol is used to help drive in the tanning agents, or to serve as a bleach when especially light leathers are desired.

The mineral tanning agent, Zircotan, also has application in the snakeskin tannery. On snakeskins that are naturally light-colored, or on those skins which have had the special bleaching, tanning with this agent produces a beautiful leather, with the dark markings standing out against the white background.

After tanning, the skins are fat-liquored with oils and grease to nourish them and keep them soft and pliable. They are then ready for drying and bleaching.

Reptile leathers are commonly dried at this stage by being hung over sticks in a dry loft or "crust" room. Skins in the crust condition are then "wet back" to prepare them for subsequent processing operations such as retanning and finishing.

Large-headed nails, resembling roofing nails, are used. The tacker feeds them from his mouth with the same hand that wields the special little tack hammer, leaving the other hand free to stretch and smooth the leather as the tacks are driven in place.

When the skins have dried and are removed from the tacking boards, the tacks are collected and sent to the sterilizer. Here they undergo a two-hour treatment during which they are cleaned and prepared for re-use.

Much reptile leather is dyed with aniline dyes and then finished with "seasons," often casein preparations. The dye has little effect on the darker-pigmented areas of the skin, and brilliant leathers with attractive contrasting patterns thus result.

Lizard skins, and some other reptile leathers, are smooth-plated on an embossing press as the final step before they go to the shipping room.

The tanner is through with the skins when they are shipped to the manufacturers of leather goods. Most of the snakeskin leather is used in making shoes and handbags—often in matching ensembles. Belts and leather novelties are also made from snakeskins. Although it has a deceptively fragile feel, properly processed snakeskin leather is said to be amazingly tough and durable. It is common practice to "compound" snakeskin leather—that is, to cement the thin skin to a cloth backing, but this is done to provide greater "body" rather than increased strength in the leather. Alligator and lizard leathers have practically the same application as snakeskin leather with a greater amount going into the manufacture of larger bags and cases.

Carbon Packing Rings

THE New York Naval Shipyard Naval Base Station, Brooklyn, N. Y., has developed a method of manufacturing carbon packing rings such as those used in turbines that results in a uniform precision interchangeable sectional carbon ring.

Formerly it was necessary to match mark each end of every section of each ring and install according to the marking. No such markings are necessary with this new method. Heretofore, if one section were damaged, it was necessary to replace the entire ring. With the new method any part of one set is now interchangeable with any like part of a similar set. The new method also reduces the chance of error in installation because of improper matching of parts. Furthermore, it is reported that costs were cut an estimated 75 per cent. Because of the variety of types and sizes, exact dimensions have not been given of the jigs and fixtures used. It is necessary to design the jigs and fixtures according to the type and size of packing required.

The following is a description of the operations to complete any carbon ring by this new method:

1 Using a sheet of carbon 12 × 12 in. and about $^1/_8$ in. greater in thickness than the finished size, lay out the carbon rings to $^1/_4$ in. larger than the final diameter to allow for finishing.

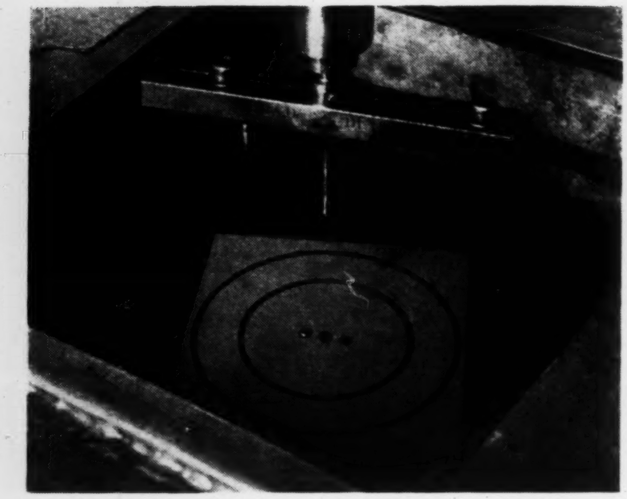


FIG. 3 CUTTER USED FOR CUTTING OD AND ID

2 Sheets of carbon which have been laid out are next sawed into squares on a "Doall" type saw.

3 A $^1/_4$-in. hole is drilled in the center of the layout.

4 The square cut-out blank is placed on the drill-press table and a drill jig is used to drill two $^1/_4$-in. holes $^7/_{16}$ in. in distance on either side of the center hole.

5 The blank is then placed on a drilling fixture having two pins for the drilled holes, and a hole in the fixture corresponding to the center hole of the carbon blank.

6 A fly cutter with a center pin and two cutter blades is held in the spindle of the drill press; one cutter blade is set for $^1/_{16}$ in. diameter less than the finished ID; the other blade is set for $^1/_4$ in. larger than the finished OD. The blank is then cut out one half the thickness on one side, turned over, and cut through the other half to prevent chipping of the outer edges. See Fig. 3.

7 A number of blanks are then placed on a Blanchard grinder and ground uniform and parallel. A clean-off cut is taken on one side. Then the blanks are turned over and ground to the correct thickness. This makes both sides parallel to each other and the working surfaces for all future operations.

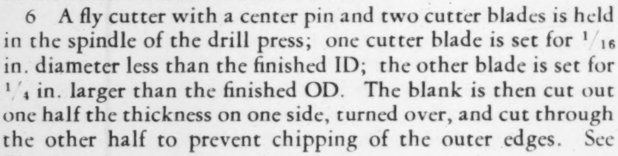


FIG. 4 SLITTING OPERATIONS ON DOALL SAW SHOWING FIXTURE

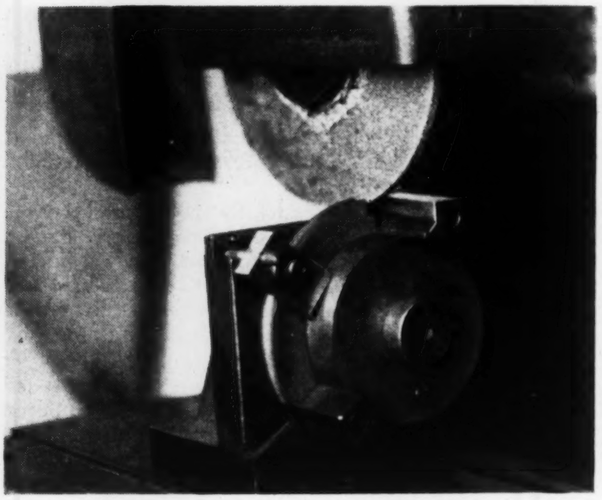


FIG. 5 GRINDING THE CONNECTING SLOT

8 A fixture is attached to the Doall saw, having a center shaft to hold four to six rings, with holding pins placed against the OD. It is of the indexing type with locating pin and holes to position each segment for cutting. The fixture rides on two parallel tracks and slides into the band saw to cut each of the three or four segments as the type ring requires. See Fig. 4.

9 The segment is placed on the table of the grinding machine. The butt ends are then ground uniform by means of a positive stop set previously.

10 Using the butt ends as locating points, two segments are placed on a face plate having metal straps set at exactly 120 deg for the three-piece ring and 90 deg for the four-piece ring. The ID is ground to 0.0625 in. +0.001 in.—0.000 in., smaller than the desired finished size.

11 Five complete rings are placed on a special mandrel that is 0.001 in. under the present size of the rings. The mandrel is placed between centers and the OD is ground to the finished size.

12 A face-plate type of fixture, which fits into a lathe headstock taper, holds the carbon rings by means of clamping rings,

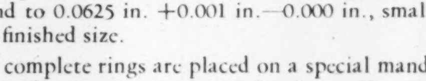


FIG. 6 FINISHED PACKING RING

the garter spring groove is then ground to finish dimensions (as per drawing).

13 Utilizing a nest-type face plate (which locates the ring on the OD and is clamped in correct position by means of a ring over the carbon, with three clamping straps) the ID is then finish-ground to required size.

14 Each segment is placed on a lathe fixture and the connecting slot is ground uniform. See Fig. 5.

15 The segments are assembled with the spring in position and placed on an illuminated table for inspection. See Fig. 6.

Printed Circuits

THE proceedings of the First Technical Symposium on Printed Circuits held October 15, 1947, in Washington, D. C., under the sponsorship of the Aeronautical Board and technical direction of the National Bureau of Standards, have recently been published as a pamphlet, "New Advances in Printed Circuits," Miscellaneous Publication 192, and can be obtained for 40 cents each from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

In his summary of the symposium, Dr. Cledo Brunetti of NBS, said it may be concluded that the conductors of an electronic circuit may readily be printed by any one of a large number of successful methods. Many of these methods have been proved in practice on production lines; others have just been started. A principal item requiring further attention to achieve over-all perfection in printing circuits is the development of improved methods of printing resistors without the requirements of expert knowledge or experience.

He pointed out that not all the components of an electronic circuit may be printed. The practice has been adapted principally to conductors, resistors, capacitors, inductors, shields, and antennas as well as some miscellaneous electronic accessories. Vacuum tubes have not yet been printed but there are ideas for incorporating a vacuum tube within a flat ceramic sheet, he revealed.

The paint stenciling and the spraying processes are the ones which have been used with greatest success in making complete electronic circuits today. Most of the printed processes are adaptable to manufacture of practically all of the ordinary low-power electronic devices. The printed-circuit techniques may be used at high as well as low frequencies.

The problem of tolerances can no doubt be overcome. As soon as such a problem is turned over to industry, American ingenuity finds the answer.

Dr. Brunetti stated that a properly designed printed circuit offers size reduction comparable to the best of standard miniature electronics practice and in certain cases affords a degree of miniaturization unobtainable by other means. The subminiature transmitters and the amplifiers in which the circuit is painted on the tube envelope are examples of miniaturization unattainable by other means. Other examples are the tiny commercial filter and interstage units printed on high-dielectric base plates which are now on the market. A pi filter made in this way, consisting of two capacitors and a resistor, has a total volume of less than 0.006 in. A complex audio-coupling circuit occupies a volume of less than 0.03 in. These are items which are on the commercial market and hence the production problems have been overcome.

Just how much space saving may be realized depends on the application, he said. Standard electronic components are now available in such miniature size that complete amplifiers may be built into volumes of less than one cubic inch using standard methods. In the printed electronic circuit, most of the volume is occupied by the base material. By providing thinner base materials, or better yet by applying wiring to an insulated outer or inner surface already present in the assembly such as the tubes themselves or part of a plastic cabinet, an additional reduction in volume occupied by the wiring may be had. Someone has suggested that radio manufacturers simply print the circuit on the inside of the cabinet and use the cabinet for storing magazines.

While definite advantages are realized when printed circuits are produced in large quantities, it is also possible to use some of the techniques, such as the painting process, for making a few tailored sets, Dr. Brunetti pointed out. The advent in the market of a new printed hearing aid proved that printed circuits are feasible in moderate quantity production.

A manufacturer does not need to equip his plant to produce sets that are printed in every electrical detail to take advantage of printed circuits. Some have introduced the process of printing only a subassembly or an interstage network of a complex set. Others have printed only the conductors, and have used standard resistors and capacitors for the remainder of the circuit.

One radio incorporates the standard interstage coupling networks available on the market today and illustrates one method of introducing printed circuits. The interstage coupling units cost less than the standard components plus the cost of wiring and of handling components, he said.

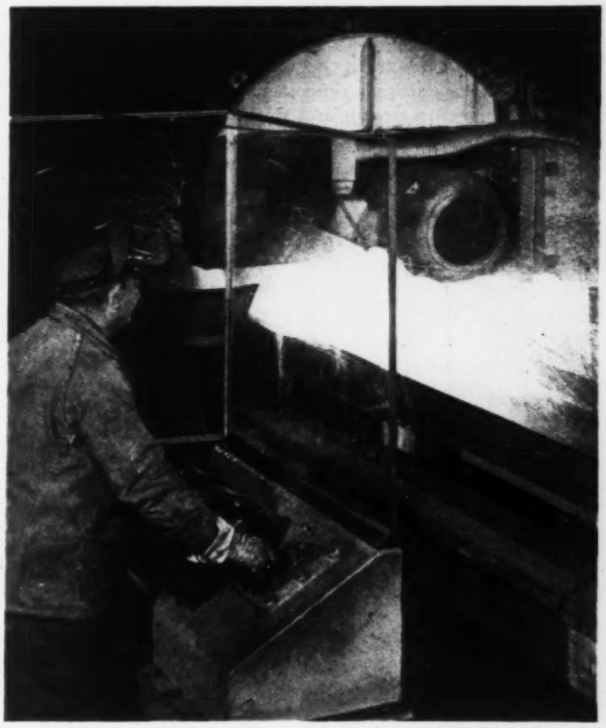


FIG. 7 HIGH-SPEED FRICTION SAW MELTS STEEL AS IT CUTS 13 FT PER MIN

(Built to specifications of United States Steel Supply Company engineers to give quicker service to warehouse customers, the 60-in. blade is operated by remote electrical control and was designed to make square burrless cuts across heavy steel sections, such as structural shapes. Its teeth travel faster than 320 mph at its normal speed of 1750 rpm. When the blade makes contact with hard tough steel, friction generates more rapidly than the material can absorb it. The intense heat melts the surface and the teeth carry it away. A transparent plastic shield assures perfect safety for the operator as the sparks fly fast. This is the first of several high-speed friction saws to be installed at warehouses of this United States Steel Corporation subsidiary and is said to be the most modern in the steel industry.)

Another measure of what is possible, Dr. Brunetti reported, has been provided by the development in England of a completely automatic apparatus for wiring panels. It is a spraying-milling technique designed for the automatic manufacture of small ac-dc radios. A plastic plate is used with molded indentations for conductors, inductors, capacitors, and mountings for other components. The plate is fed into an automatic machine which sandblasts both sides, sprays the surfaces with zinc, mills the surfaces to remove the surplus metal, tests the resulting circuit, sprays on graphite resistors through stencils, inserts tube sockets and miscellaneous small hardware, tests the unit again, and applies a protective coating over the panel, all at the rate of 20 sec per panel. Each operation is controlled separately by electronic circuits and operates only on the arrival of a panel. Should two successive panels be rejected at any point on the line, all previous operations are stopped until a personal inspection is made. All panels beyond that point are continued on to completion. In a single radio set the need for hand assembly of 30 components was eliminated and 80 hand-soldered connections were said to be avoided.

Experienced judgment leads to the conclusion that the new techniques are practical; that they promise size reduction comparable to the best of standard miniature electronics practice, and in certain cases, afford a degree of miniaturization unobtainable by other means. Conventional production methods cannot easily compete with printed circuits from the standpoint of uniformity and minimum required inspection since each of the latter units is a duplication of a master pattern.

Manufacturers evaluating the advantages of printed circuits often compare them with present production costs based on years of engineering design and production experience. The initial printed assemblies which have come on the market have been found in general, to cost no more, and in most cases less, than present costs of conventional methods of production. Remembering the pattern new developments usually follow, one can reasonably expect that if the costs of the new techniques today do not exceed those attained by years of practice with the conventional methods, it should not be long before printed techniques will reflect considerable savings in both engineering and production. When the initial production difficulties are inevitably mastered, printed circuits should provide substantial reduction of assembly, inspection, purchasing, and stocking costs and problems.

Ball-Bearing Grease Tester

SINCE the exact correlation between physical and chemical characteristics and lubricating ability of ball-bearing grease has not been established, some sort of functional testing is necessary. Working in co-operation with the American Society for Testing Materials, the General Electric Company has developed a small reliable and highly simplified functional tester. This equipment is now being used by a number of oil refineries, an optical company, and a large metal producer.

By maintaining test conditions similar to those encountered in the field and by accelerating those conditions contributing to the destruction of a grease, a rapid comparison can be made of one grease with another. Testing time has been reduced from months to a matter of weeks in some instances.

Essentially, the tester consists of a housing within which is a shaft rotating inside a guide bearing and a bearing packed with the grease to be tested. This shaft is belt-driven, normally at 3500 rpm, though this speed can be altered by changing pulley sizes.

Heat radiated from an open-wound Nichrome heater is conducted to the test bearing and guide bearing through the housing and the shaft. By locating this heating element between the two bearings, the heat source and heat-flow paths in an electric motor are simulated. Heater output is controlled by a thermostat to maintain test bearing temperature at 100 C. When the bearing overheats because of lubrication failure a second thermostat shuts off the heater and drive motor. Operating time is recorded on a cyclometer-type counter marked in tenths of hours that will total time up to one year.

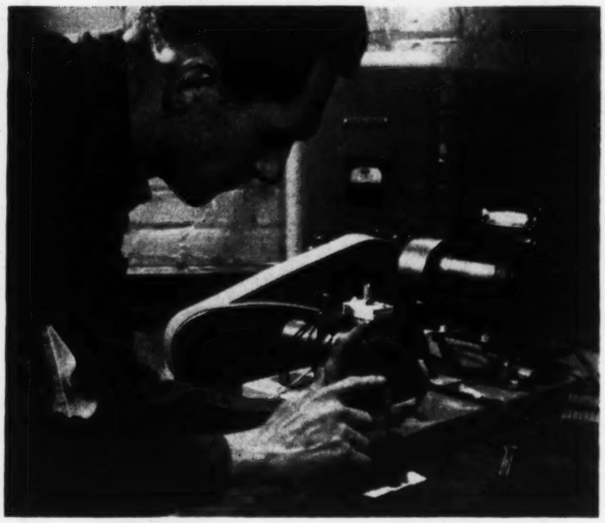


FIG. 8 BALL-BEARING GREASE TESTER

Physics Research

ADVANCED physics research on cosmic rays, in the coming year, may break down the mystery still surrounding the structure of the atom, Ernest C. Pollard, associate professor of physics at Yale University, predicted during a recent radio broadcast. He said that high-energy machines that produce man-made cosmic rays were now being completed in this country and in England, and extensive research on cosmic rays will get under way this year.

Mr. Pollard, who designed the atom-smashing cyclotron at Yale, pointed out that in addition to cosmic-ray research, significant advances in the fields of ultralow temperatures, biophysics, and microwaves, will also take place.

Explaining the importance of cosmic-ray research, Mr Pollard stated that the properties of cosmic rays may enable us to understand the inner works of the atom.

He said that cosmic rays are very high-energy fast particles which are bombarding the earth from nobody knows where. They represent the extreme of energy and therefore are most intriguing.

Comparing the atom bomb with the cosmic rays, he explained that in the atomic bomb no one particle has much more than a million electron volts of energy, while in cosmic rays we find particles of energy with billions of volts or better.

It is a remarkable fact that while we have learned one way to release atomic energy, we have not learned where it comes from or how it is involved in the atom, he stated.

Mr. Pollard carried his prediction a step further. He said that enough knowledge will be gained in 1949 to start a real theory of the atomic nucleus and that the man who formulates this theory will be under 26 years of age.

Turning to the other three fields of research in physics, Mr. Pollard said that extreme cold temperatures make the study of matter that much simpler. When the temperature approaches absolute zero, more than 400 F below zero, significant reactions begin to happen.

With ultralow temperatures, unlimited amounts of electric power could be sent down wire as thin as a hairpin, he asserted. One can imagine the bottom being knocked out of the copper market by the use of such superconductors. But such superconductors are still experimental wonders in the laboratories, and require much more research before their benefits can be put into practical use, he said.

Mr. Pollard pointed out that physics has become increasingly important in biology in the joint field known as biophysics.

In the past year the structure of penicillin was determined by means of x rays, and perhaps in the coming years the structure of protons may become better understood through physics, he said.

Also, physics is called on to help in the attack of the problem of self-duplication—the genetic parts of the living cell.

Mr. Pollard, in discussing the fourth field of research dealing with microwaves, said that the use of microwave radar is enabling us to follow the paths of meteors for the first time and to measure their speeds. This process is telling us a lot about our own atmosphere as well as about the meteors themselves.

In concluding, Mr. Pollard said that the number of students taking physics in colleges and universities has tripled since the war, reflecting the increased interest in this branch of science.

Danger Area

THE United States Atomic Energy Commission recently gave public notice that the danger area surrounding Eniwetok Atoll will continue to exist until further notice. The danger area was previously prescribed for a period beginning January 31, 1948, to continue throughout the calendar year 1948. Eniwetok Atoll is the site of the Commission's proving ground for routine experiments and tests of atomic weapons.

The area designated as a danger area is bounded as follows: Beginning with a point at 10° 15′ North latitude and 160° 35′ East longitude, north along the meridian of 160° 35′ East longitude to a point at 12° 45′ North latitude, 160° 35′ East longitude thence east along the parallel of 12° 45′ North latitude to a point at 12° 45′ North latitude and 163° 55′ East longitude, thence south along the meridian of 163° 55′ East longitude to a point at 10° 15′ North latitude and 163° 55′ East longitude thence west to the point of beginning.

Notice of the continued designation of the danger area is being made in air and marine navigational notices.

Automatic Accounting

AN automatic accounting system which can keep track of thousands of dial telephone calls—remember who made them, what numbers were called, how long the conversations lasted, and then add up and print detailed charge information—has been introduced by Bell Telephone Laboratories.

The first installation was recently made in the Philadelphia area, with part of the intricate equipment in the city itself and other necessary apparatus in near-by Media, Pa., a residential suburb, where the new service is being introduced.

It is known as AMA (automatic message accounting).

The system operates as follows:

The "electrical brain" of the central-office switching system recognizes, on each local call, whether the subscriber making it has flat-rate or message-rate service, or, if the call is for a more distant point in the metropolitan area, which he can dial under the new system, whether the call is to be billed as a toll call. Thus it knows whether any record need be made of the call and, if so, in what detail.

All of the information to be recorded is first translated into numerals, which are in turn represented by tiny holes punched in varying patterns on a 3-in-wide paper tape. In this way a record is kept, where required, of the calling and called numbers, and the month, day, and exact time to tenths of minutes at which the conversation begins and ends. Each of these entries is made on the tape in a fraction of a second.

Thus, immediately after dialing, both the calling and the called numbers are punched into the tape. These entries are controlled by the electrical brain of the switching system, which has momentarily "memorized" these numbers to set up the connection.

Later, after the called subscriber has answered, the starting time of the conversation is recorded, and finally, as soon as the parties have finished talking, the time of disconnect is entered.

The tapes are cut daily and taken to the accounting office, where clerks feed them into the first of five successive machines. The first machine locates and groups together the various items of information on any single call—an ingenious operation required because the entry denoting the end of a conversation may appear on the tape at a point several yards distant from the starting entry. Between the two there may be many other items—records of hundreds of other calls.

Other machines in the series rapidly go through the basic mathematical processes of addition, subtraction, multiplication, and division. Certain relatively complex calculations are also made in converting the elapsed time of a call into chargeable units. A single machine can be set to deal with as many as eight formulas and will select the proper one automatically in order to solve the problem.

The equipment also performs a variety of other office tasks. For example, it sorts out all the thousands of calls according to the directory number of the subscriber who made them, and finally prints the details of the calls for use in making out bills.

One of the tape reels, filled to capacity, would contain code records on approximately 25,000 local and toll calls. The first

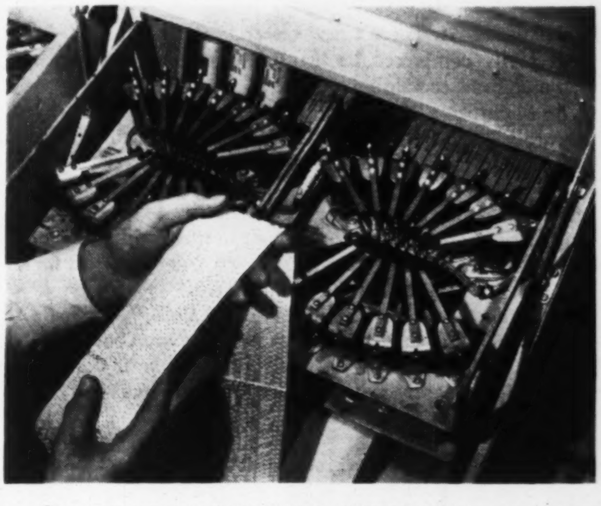


FIG. 9 INTRICATE TAPE-PUNCHING EQUIPMENT IS PART OF NEW AUTOMATIC MESSAGE ACCOUNTING SYSTEM DESIGNED BY BELL TELEPHONE LABORATORIES FOR USE IN HANDLING TELEPHONE BILLING INFORMATION

processing machine in the accounting office is able to "read" all this information in about two hours. It scans perfectly over 80 coded digits per second.

The entire system is said to be as thoroughly reliable as modern engineering and human ingenuity can make it. As one safeguard against possible breakdown, special tapes containing the records of test calls are run periodically to give advance warning of any mechanical difficulty.

Plutonium Production

THE United States Atomic Energy Commission announced recently that E. I. du Pont de Nemours and Company of Wilmington, Del., will survey the total problem of research and engineering involved in improving the chemical processes used in production of plutonium.

Plutonium is one of the two fissionable materials to which a major portion of the production program of the national atomic-energy program is devoted. Improvements in the chemical phases of the production process offer the best promise of increasing the amount of plutonium produced from a given quantity of uranium, and of simplifying the handling of the wastes of the production process.

Since it assumed direction of the atomic-energy program in January, 1947, the Commission has given close attention to developing of improvements in the chemistry of plutonium. The complex studies required have been undertaken by several different institutions and industrial concerns at a number of different locations.

In order to make sure that the Commission staff has the benefit of the widest range of expert advice in developing the total program for solving the many problems involved, the Commission now has obtained the services of the du Pont Company in examining the entire scope of work that needs to be undertaken. The survey is expected to lead to important conclusions and recommendations concerning the plutonium chemistry development program, and to measures which will integrate the program into the strongest possible attack on this vital phase of atomic-energy development.

New Research Aircraft

THE U. S. Air Force's new research aircraft, the X-4, successfully completed its first flight test at Muroc, Calif., Air Force Base, remaining aloft 18 minutes.

The sweptback wing, semitailless airplane was built by the Northrop Aircraft Corporation, Hawthorne, Calif., and was designed for stability and control investigations at high subsonic speeds.

The X-4 is patterned after Northrop's B-35 and B-49 type Flying Wing. It incorporates elevons in the trailing edge of the wing for aileron and elevator action. A single vertical fin and rudder provide lateral stability and control.

The miniature flying laboratory, containing National Advisory Committee for Aeronautics stability and control instruments, is another in the series of research aircraft designed to explore flight characteristics of aircraft of different designs and power plants in high subsonic, transonic, and supersonic ranges.

Powered by two gas turbines, the X-4 is of small configuration. It is approximately 20 ft long, has a wing span of approximately 25 ft, and is approximately 15 ft high. It has a design gross weight of about 7000 lb.

The X-4 has a tricycle landing gear and is equipped with a pilot ejection seat.

Industrial Seismograph

A NEW tool to help engineers combat vibration—a portable "seismograph" for use in industry—has been developed by The Barry Corporation of Cambridge, Mass., and the Westinghouse Electric Corporation, Baltimore, Md.

The first application has been made in measuring the vibration of walls in a textile mill. Because of its compactness and easy portability, it is expected that the instrument may be used to analyze vibration problems on machinery and other equipment as well.

The industrial seismograph, so-called because it utilizes the same principle employed in instruments registering earthquake shock, is a combination of a special seismic pendulum mounting designed and manufactured by The Barry Corporation, and the Westinghouse Vibrograph.

The Vibrograph, about the size of an ordinary box camera, ordinarily embosses a permanent record of vibrations on a transparent film. It records over the range of 600 to 15,000 cycles per minute and amplitudes as low as 0.001 in. or as great as $^{1}/_{16}$ in. Mounted in the Barry frame, vibrations with a frequency as low as 120 cycles per minute can be measured even in swaying buildings where no steady reference point is available.

The Barry seismic pendulum provides a Vibrograph support whose natural frequency is lower than the frequency of the vibration to be measured. The Vibrograph thus tends to remain stationary in space. The pendulum is composed of a triangular arm supported from a vertical column by means of frictionless elastic hinges. The low natural frequency is attained by mounting the Vibrograph relatively close to the hinges and setting a large mass in a pan at the free end of the arm. The Vibrograph includes a prod adapted to contact the structure whose vibration is to be measured. This contact is achieved, in the case of the wall of a building, by setting the seismic pendulum in such a position that the prod contacts the wall.

Flying-Wing Fighter

A NEW Navy swept-wing jet fighter designed for shipboard operation, the Chance Vought XF7U-1, has successfully completed its initial flight tests at the Naval Air Test Center, Patuxent River, Md., it is revealed in the December, 15, 1948, issue of the CADO *Technical Data Digest*.

The tailless XF7U-1 is in reality a flying wing. The arrangement overcomes inherent handicaps of conventional designs, and is totally unlike that of any service aircraft thus far revealed.

Incorporation of the sweepback of the wings, known to be desirable in high-speed airplanes, with a twin-engine installation, makes this Navy fighter potentially capable of speeds in excess of current models of operational jets, land or carrier based. It is rated in the "over-600-mph class."

The unconventional appearing airplane has two vertical stabilizers and rudders located at the trailing edge of the wing but longitudinal and lateral control are obtained through the use of a pair of "ailevators," which are combined ailerons and elevators.

The XF7U-1 has a high rate of climb. This is primarily due to its high thrust-weight ratio, and its tailless design, which presents less exposed surface to create drag.

A unique feature of the XF7U-1 is the absence of landing flaps. To achieve the relatively low speeds necessary for landing aboard carriers, the airplane is equipped with leading-edge slats. The extension of these slats during a landing approach increases the wing lift and delays the stalling point. For aerial maneuvers, as well as for landing operations, speed brakes are located at the trailing edge of the wings for reducing speed rapidly.

The XF7U-1 power plants are Westinghouse turbojets. For combat performance, high bursts of power may be obtained through afterburners, thereby obtaining large increases in thrust for short periods. The air-intake ducts are at the roots in the leading edges of the wings.

To overcome the tremendous forces brought on by high-speed flights, all controls in this Navy fighter are provided with hydraulic "boost." In the boost system the pilot provides, in effect, only the signal for the work he desires to be done; the actual work is performed by jacks, not unlike the hydraulic jacks used to raise automobiles. And since the control surfaces are hydraulically operated, the designers have had to incorporate an artificial "feel" for the pilot which simulates the control forces encountered in conventional aircraft.

Exceptional flight visibility is obtained by having the cockpit situated well forward in the nose. It is pressurized to assure the pilot of comfortable breathing at the altitudes obtainable.

Another feature of the XF7U-1 is the use of magnesium in certain areas instead of the usual aluminum-alloy covering. Although magnesium has been used in other aircraft, the XF7U-1 has used more of this material than any other craft, resulting in a considerable decrease in weight.

The aircraft has an ejectable-type pilot's seat for bailing out at high speeds should this become necessary through enemy action or other difficulty. Both the pilot and the seat are ejected at a velocity calculated to clear all parts of the aircraft structure. In the final descent the seat is jettisoned for a normal parachute landing.

The XF7U-1 is a conventional carrier-based fighter in every other respect. Guns normal for this type are installed in the XF7U-1.

Standardized Automobiles

LOWER selling prices for British cars are the object of measures announced by Britain's Ministry Supply, according to British Information Services.

Mr. George Strauss, the minister, stated that advances will be achieved in two ways: the first, through a free exchange of ideas and methods aimed to increase productivity. To this end all United Kingdom car and commercial-vehicle manufacturers agree to make available for inspection to the 600 member firms of the Society of Motor Manufacturers and Traders not only their factory premises and plant, but also their technical and administrative resources, such as drawings, operation sheets, and details of jigs and tools. Factory-planning staffs will be made available to help supplies of materials and components.

Second is increased standardization, and will be confined at first to the "Big Six"—Austin, Nuffield, Rootes, Vauxhall, Standard, and Ford. These firms are to take immediate steps to accelerate the use of common accessories and components, and generally to improve the whole process of standardization.

Atomic Ship Propulsion

THE Chicago Operations Office of the U. S. Atomic Energy Commission announced recently that a letter contract has been entered into with the Westinghouse Electric Corporation of Pittsburgh, Pa., for the construction of an experimental nuclear reactor to meet specifications for eventual use for ship propulsion.

Work under the contract will be carried on in co-operation with the Argonne National Laboratory, major center of the Commission's reactor development program. The objective of the development project is to meet requirements provided by the Navy Department Bureau of Ships for the propulsion of naval vessels.

Opportunities for and Responsibilities to the Young Graduate Engineer in Industry

(Continued from page 152)

As illustrations of what might be done, consider giving more widespread permission to publish findings by individuals or groups of engineers, where such publication would not be harmful to basic company interests. Leaves of absence to attend professional meetings, possibly some university refresher courses, regular meetings of the scientific personnel at the plant with presentation and discussion of papers, outside speakers, etc., all these would contribute toward the element of recognition.

Communication. Free expression of opinion and fair treatment are rights that all democratic citizens expect in all phases of their activities, including their job. Yet one meets a good deal of complaint on the part of the engineers that their superiors are not sympathetic, that they have no access to higher management, do not understand company policy properly and are not consulted about it, cannot voice their suggestions and grievances properly.

This difficulty might be overcome by regular formal or informal meetings between the engineers and various members of higher management. Some thought might also be given to improving the methods of airing complaints.

"INDUSTRIAL STATESMEN" NEEDED

If businessmen—the industrial management leaders of today—expect to find qualified hands in which to place the future of their businesses and the nation's economic health, they cannot sit back and wait for tomorrow's engineers to come knocking at their office doors. They must engage actively in their development—now.

If the American system of free enterprise is to survive, we need a greater and greater number of "industrial statesmen." Such statesmanship requires full and deep understanding of the historical development, of the motivating philosophies, of the basic principles and the requirements for life of our economic system. It needs even more—it needs dynamic and conscious drive to make the system work.

The American free-enterprise system is "the one" that is based upon, encourages, and rewards individual creation of products, services, and ideas. The real industrial statesman is the one who realizes fully the driving motive inside of individuals to create something, and who fosters it and gives it opportunity to express itself fully and quickly.

Engineering is a creative profession. Its human products are trained and educated to create. The greatest satisfaction to an engineer is realization that he is creating or assisting in creation. The individual, company, national, and world status of the engineer which gives greatest satisfaction to all, depends upon the preservation, improvement, and growth of the American free-enterprise system. What a challenge to American and industrial statesmanship!

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Gas-Turbine Power

Effect of Fuel Properties on the Performance of the Turbine Engine Combustor, by Louis C. Gibbons and Edmund R. Jonash, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1948 ASME Annual Meeting paper No. **48—A-104** (mimeographed).

The influence of fuel volatility and molecular structure were studied independently to determine their effects on combustion efficiency, altitude operational limits, and carbon formation in turbojet combustors. Certain trends were established for the influence of the two fuel variables, volatility and molecular structure, at constant inlet-air temperature, pressure, and velocity, and with one fuel nozzle. Investigations were then conducted to determine if these combustor variables would change the relative performance of fuels as established at the one condition.

The examinations have indicated the following results:

At sea-level operating conditions all of the fuels examined gave good combustion efficiencies, but at altitude conditions, increasing the boiling temperature of fuels gave decreasing combustion efficiencies.

At adverse conditions of inlet-air temperature, pressure, and velocity, low-boiling-temperature fuels gave limits of temperature rise, whereas high-boiling fuels did not give a temperature-rise limit under the same conditions of operation.

High-boiling-temperature fuels allowed higher altitude operational limits than low-boiling-temperature fuels. This was due to the temperature-rise limit.

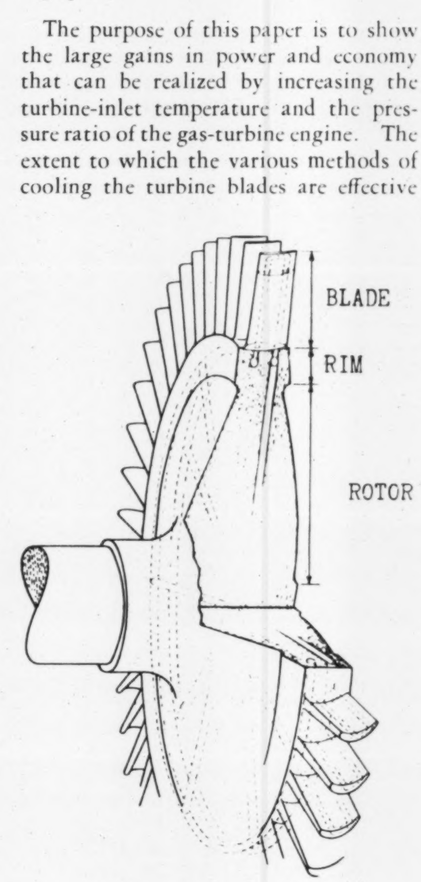
Improved combustion efficiencies may be attained by improved fuel-spray configurations or by nozzles that will maintain optimum injection pressure over a wide range of fuel flows, thereby maintaining fuel-air mixtures that are neither too rich nor too lean in the primary combustion zone.

Carbon deposition tendency of fuels may be correlated with average boiling temperature and hydrogen-carbon ratio of the fuels.

It may be concluded that in turbojet combustor design, the inlet-air conditions, the fuel-injection system, and the fuel all have an important influence on combustor performance at high-altitude conditions. Therefore, if possible, the fuel for ultimate use should be designated when the combustor and engine are first designed, rather than to develop the engine on any fuel at hand and expect optimum performance with another fuel that may be required for service use.

The Advantages of High Inlet Temperature for Gas Turbines and Effectiveness of Various Methods of Cooling the Blades, by Oscar W. Schey, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1948 ASME Annual Meeting paper No. **48—A-105** (mimeographed).

The purpose of this paper is to show the large gains in power and economy that can be realized by increasing the turbine-inlet temperature and the pressure ratio of the gas-turbine engine. The extent to which the various methods of cooling the turbine blades are effective in obtaining these high gas temperatures is shown. The importance of turbine-blade cooling is discussed as a means of using less of the strategic or scarce materials.



ARRANGEMENT OF INTERNATIONAL COOLOUT PASSAGES

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According to the paper, turbine cooling for aircraft power plants requires that the heat losses be reduced to a minimum in order to keep the drag of the cooling system small. High-temperature protective coatings of extremely low thermal conductivity (thorium oxide) might be used to reduce the heat flowing into the blades. The effectiveness of the comparatively cool layer of gas in contact with the cooled blades in insulating the blade from the hot gases should be determined. Such an insulating layer may be effective enough to reduce the importance of the ceramic coating, particularly if the flow is laminar. Such a layer should be very effective in protecting the trailing edge of blades which cannot be easily cooled because of mechanical limitations on the size of the passage. Consideration should also be given to the material problem from the viewpoint of using nonstrategic material and also material that will permit maximum temperature with minimum cooling or heat loss. A heat-resisting material of high conductivity is most desirable because the temperature is more uniform through the blade and only heat flowing through the coating is transferred to the cooling medium. A coolant with a high specific heat and boiling point is also desirable. The combination of a low-conductivity protective coating, heat-resisting material of good conductivity, and coolant liquid of high specific heat and suitable for high-temperature operation should result in a compact cooling system of low cooling drag and weight. The possibility of reducing the heat losses to the extent that sufficient cooling can be obtained by circulating the fuel through the wheel and blades before it is sprayed into the burner should also be considered.

It is believed that an aircraft engine with a liquid-cooled turbine can be built for operating at stoichiometric temperatures and that it will be as simple and more reliable than present engines. Burner losses can be reduced and possibly eliminated because the whole chamber will be one burner. Tailpipe burning will be unnecessary because all burning can be done in the combustion chamber with greatly improved economy. Because sufficient cooling will be provided for any possible maximum temperature, limiting temperature controls will be unnecessary. A uniform mixture distribution in the burner essential for uniform temperature distribution can be obtained by the principle of the injection impeller. Temperature distribution at the inlet of the turbine will be improved because there will be no problem of mixing hot gas with the air.

It is concluded that turbine cooling which permits high turbine-inlet temperature would result in remarkable improvements in economy and power of turbine-propeller and turbojet power plants and gas-turbine engines used for industrial installations.

The application of turbine cooling to present gas-turbine engines should result in a large saving of strategic materials without any sacrifice in performance.

Air cooling of the rim or roots of turbine blades should give an increase in effective gas temperature of 100 to 150 F; hollow-blade cooling should give 300 to 500 F with approximately 8 per cent dilution without inserts and the same effective cooling with less than 3 per cent dilution with inserts; film cooling or finned hollow blades of good heat-resisting alloys should give 1200 to 1500 F with 6 per cent dilution; and liquid cooling should permit safe operation at stoichiometric temperatures.

Combustion System for Burning Bunker C Oil in a Gas Turbine, by Bruce O. Buckland, Mem. ASME, and Donald C. Berkey, Jun. ASME, General Electric Company, Schenectady, N. Y. 1948 ASME Annual Meeting paper No. **48—A-109** (mimeographed).

The combustion system for a 4800-hp gas turbine is described and the results of tests made during its development are given. The liner temperatures, outlet-gas-temperature pattern, smoke and carbon formation, ignition, and operating range obtained with the combustion system are given, and factors which affect these features are discussed. The properties of the fuel used are outlined and the effect of these on the gas turbines is described. Comparisons are made of tests on the complete plant with tests of the combustion components.

The General Electric Company Gas Turbine Division in Schenectady has designed and built a 4800-hp gas turbine for locomotive service. This plant is arranged to burn Bunker C fuel oil or any other fuel oil at least as good. Combustion components have been tested in order to accumulate the information needed for the design of the combustion system. The unit itself has been tested for about 700 hr, during which time approximately 230,000 gal of Bunker C have been burned.

The tests made thus far on the components and on the unit show that the combustion system is generally satisfactory. The tests also indicate that the combustion-system pressure drop and the liner temperature may profitably receive additional attention now. The remaining features are sufficiently well developed so that further operating experience is required to point the way to further improvement. The pressure drop at present is somewhat high but this, it is felt, can be reduced with further development now in progress. More efficient liner-cooling arrangements are being designed and tested to produce cooler and longer-level liners.

Attempts have been made in the testing to obtain Bunker C oils which would introduce the obstacles associated with the quantity and character of the ash. The tests show that these obstacles have been overcome on the oils tested. However, Bunker C fuel is a rather indefinite substance and the qualities of all of the ashes to be encountered in the fuel, as well as their effect on the turbine, will have to be found by operating experience. This experience may show that further improvements, such as the forced cooling of turbine parts, may be required if and when turbine-inlet temperatures are increased. Until operating experience shows some limit to be necessary, no limits have been specified concerning the quality of the fuel to be used on the unit except that it shall be commercial Bunker C.

A Research and Development Laboratory for Aircraft Gas Turbines, by M. C. Hemsworth, General Electric Company, Lynn, Mass. 1948 ASME Annual Meeting paper No. **48—A-134** (mimeographed).

The aircraft gas turbine has been an essential element in the phenomenal advances in military-aircraft speeds in recent years. In the six-year period since the first jet airplane flew in this country, this power plant has risen to a position of almost universal acceptance for fast military aircraft. Military airplanes are now flying with jet engines three feet in diameter, 12 ft long, weighing only 2400 lb, which deliver nearly 8000 hp in high-speed sea-level flight. Under these conditions, the compressor, taking in some 400,000 lb of air per hour, requires approximtely 14,000 hp from the turbine; and the combustion system, occupying only a few cubic feet, burns in the order of 12 gal of fuel every minute.

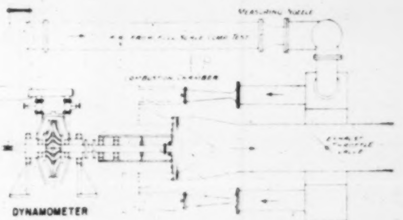


DIAGRAM OF FULL-SCALE GAS-TURBINE TEST STAND

The research and development testing facilities in the General Electric Company aircraft gas-turbine laboratory are described, with particular emphasis on the recently constructed full-scale component testing equipment, including the refrigerating equipment which provides for compressor air flow up to 250 lb per sec at temperatures down to —100 F, and a new type of dynamometer suitable for the absorption and measurement of 30,000 hp.

A review is given of the factors which determined the selection and design of the equipment and the objectives which were established for the laboratory.

Machine Design

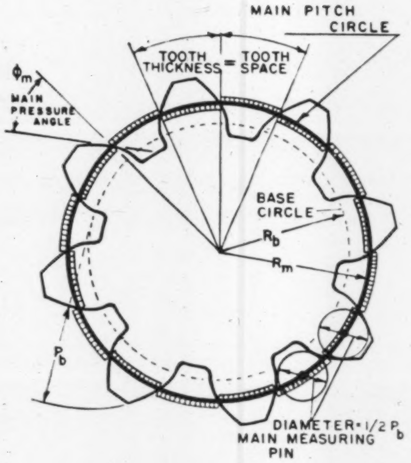
Involute-Gear Geometry, by C. E. Grosser, Mem. ASME, Syracuse University, Syracuse, N. Y. 1948 ASME Annual Meeting paper No. **48—A-73** (in type; to be published in Trans. ASME).

This paper introduces and explains the use of the graphical "belt-length-ratio" chart which is appended, and which is intended to simplify the computations necessary for the analysis of involute gears and for design of optimum performance.

It is presumed that the procedures may supplant the conventional involute-gear tables and establish computation methods to a great extent. They are intended to afford short cuts in gear calculations without loss of accuracy; and to present a more simple conception of mesh conditions, reducing the need for checking designs by accurate drawings of the gears themselves. It is recognized that large-scale drawings should be regarded as the most reliable means for checking a gear design and for analyzing conditions in a gear mesh whenever practicable. However, circumstances are often such that facilities for large-scale graphical analyses are not conveniently at hand.

It is expected that the devices discussed in the form of nondimensional or "ratio" relationships will serve the purpose of helping to visualize better the general scope of gear-mesh variations. The data are presented in nondimensional form, so that complications on account of size are eliminated, and the results of the analyses have the most general application. Gear problems are attacked by reducing all dimensions to ratio numbers, and entering them into the charts and formulas. The results then come out as pure numbers which are multiplied by the same size factors with which the original dimensions were reduced.

Included are the derivations of procedures for determining such individual gear properties as: (1) the characteristic number of teeth in contact N_c, which a given gear brings into the mesh with any other mating gear; (2) a belt-length ratio (gamma ratio) which describes tooth thickness, and which in combination with the corresponding gamma ratio of any other meshing gear, readily establishes the close-mesh center distance (or deduces the backlash of the pair on any specified operating centers); and (3) a simplified system of pitch-diameter pin measurement for establishment and inspection of gear size.



DEFINITION OF MAIN PITCH CIRCLE

(For any gear there is one pitch circle upon which tooth and space are equal. Its position depends upon the center distance at which the gear is generated.)

Textile Industry

Electromechanics in the Textile Industry, by F. D. Snyder, Mem. ASME, Westinghouse Electric Corporation, Boston, Mass. 1948 ASME Annual Meeting paper No. **48—A-139** (mimeographed).

In the design of present-day textile machines and processes, it is necessary to know the possibilities of various electrical apparatus so that an economical combination of mechanical and electrical apparatus can be made. Unless the correct combination of such apparatus is made, the most economical machine or process has not been set up.

This paper discusses the squirrel-cage motor, slip-ring motors, braking alternating-current motors by the use of direct current, and direct-current motor drives. By building motors with proper performance curves and by using the proper control apparatus, any acceleration, from the slow rate desired of a roving frame to the extremely high rate demanded by a shuttle-type loom can be obtained. By using motors with proper characteristics, speed variations of almost any desirable limits are available. Deceleration rates can be controlled and can be unbelievably fast and shockless.

The textile industry and most of its basic machinery were developed long before the electrical industry was even conceived. It therefore developed its machinery on a purely mechanical basis. When electricity did come into the picture, the textile industry was one of the first industries to adopt electric motors on a large scale, but in this early use of electricity the motor was merely a prime mover for the machine. The electrical art, however, has grown and developed and today electricity is used not merely as a source of prime motive power, but as a highly versatile force that can accomplish with ease an endless variety of tasks which were formerly considered purely mechanical functions.

Engineers Abroad

Opportunities and Requirements for U. S. Engineers Abroad, by Lloyd J. Hughlett, McGraw-Hill International Corporation, New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-122** (mimeographed).

With engineering knowledge as the basis of the world's mechanical progress and the philosophy of internationalism permeating and coloring all our thinking, it is appropriate that an attempt be made to estimate at this time the opportunities and demands placed upon U. S. engineering services and industry in foreign countries.

In order to accumulate objective information concerning the opinions, attitudes, and trends of engineering firms and U. S. manufacturers regarding the foreign field as an outlet for their services, and the establishment of manufacturing plants, two questionnaires were circulated to these groups by the McGraw-Hill International Corporation. The survey threw considerable light on the attitudes of small or medium-sized manufacturers toward branching into the foreign field. They seem to be concerned with fears of expropriations, the freezing of their profits within the country, unskilled labor, labor troubles communistically inspired, absence of markets, populations with a low purchasing power, and other problems associated with distance and differences. Probably the greatest obstacle to the migrations of small or medium-sized industry abroad is the absence of adequate machinery for bridging the gap between existing opportunities abroad and the actual acquainting and selling to U. S. private enterprise the idea of taking advantage of these opportunities.

A survey of Latin America alone shows that in 1947 the value of U. S. exports of industrial equipment totaled $474 million, nearly 800 per cent greater than 1938 and 82 per cent higher than 1946. An examination of the records of engineering companies over this period reveals that their foreign business is directly correlated with our sale of heavy equipment abroad.

The Latin Americas, like other industrializing areas of the world, have recognized that their economic expansion must stem from an internal growth in technology communicated to them from the industrialized countries. By importing engineering and management skills, they seek to attain a stronger trading position, being able to sell as well as buy in the international market.

Metals Engineering

Report on Graphitization Studies on High-Temperature Welded Piping of the Philadelphia Electric Company, by J. B. Abele, Philadelphia Electric Company, Philadelphia, Pa., and A. E. White, Fellow ASME, University of Michigan, Ann Arbor, Mich. 1948 ASME Annual Meeting paper No. **48—A-94** (mimeographed).

As a result of the heavy graphite found in boat and test samples from the Richmond Station of the Philadelphia Electric Company, and especially because of the marked graphite found in the fracture of the broken pipe section, it was decided to either replace the graphitized weld sections with new sections or to restore the graphitized sections by means of a solution treatment, which results in the conversion of the carbon in the graphite to carbide, the condition in which the carbon existed in the steel originally. Laboratory work had shown this method to be practicable, at least where the graphitization was not too pronounced.

This paper gives the procedure used for the solution treating followed by stress relieving of the 29 weld sections that were thus treated in the station. It also gives the results of physical tests on sections that were solution-treated both in the station and in the laboratory, as well as on sections "as removed from service."

Although little difference was found in the physical properties of solution-treated when compared with as removed from service, there was a marked difference in the properties, especially with respect to per cent elongation and reduction of area, of sections solution-treated and as removed from service, resulting from earlier tests.

The reason for the slight difference in properties between the comparative sections is believed due to the fact that the amount of graphite in the sections as removed from service was not great enough to cause fracture in the zone of graphite concentration although from numerous other examinations made on the piping system at the Richmond Station considerable graphite was found in the heat-affected zone in quite a number of welds.

The important result of this work is that it demonstrates the practicability of restoring lightly or moderately graphitized weld sections for further added hours of service by a rapid and relatively low-cost method.

Allowable Working Pressure for Long Tubes Subject to External Pressure, by M. B. Higgins, The Texas Company, New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-123** (mimeographed).

The allowable working pressures for tubes under external pressure are given on the chart in Fig. U-1 in Rules for the Construction of Unfired Pressure Vessels, Section VIII of the ASME Boiler Construction Code. The working pressure values in this chart were determined by the Lamé formula for thick tubes using a maximum stress in the tube wall not exceeding one fifth of the yield strength of the material. The yield strength was arbitrarily assumed to be one half of the ultimate strength or 2.5 times the working stress for all materials.

Recognizing that the values given by the chart in the ASME Code were on the conservative side, a study was made by the ASME Special Research Committee on Vessels Under External Pressure to determine if the Code rules could be liberalized. The result of this investigation indicated that Fig. U-1 could be revised so as to give more liberal values for the allowable external working pressure for tubes. The analytical approach and the recommended revision of Fig. U-1 are described.

Oil and Gas Power

Torsional Viscous-Friction Dampers, by J. C. Georgian, Jun. ASME, Nordberg Manufacturing Company, Milwaukee, Wis. 1948 ASME Annual Meeting paper No. **48—A-67** (mimeographed).

Since Lanchaster's patent on viscous-friction dampers, there have been innumerable variations of his patent for both viscous- and dry-friction dampers. Due to the fact that in the early days there was no suitable viscous fluid, most dampers were of the spring-loaded dry-friction type. Most of these devices suffer from the defect that their usefulness was dependent on close adjustment of springs, which adjustment rarely was at the optimum point after a period of operation.

Around 1930, Dashefsky developed a viscous-friction damper similar in construction to the damper described in this paper. For his viscous medium he used a furniture glue. This damper was quite successful for the use for which it was intended.

With the wartime development of the silicone oils there became available a new fluid with desirable properties necessary for the successful operation of a viscous-friction damper.

This paper describes the large torsional viscous friction of "Lanchaster" dampers manufactured for use on Diesel engines. Some properties of the new silicone fluids that are necessary for damper design, are given. The theory of the torsional viscous-friction damper as applied to multimass systems is developed. Constructional details of the damper and methods of manufacture are discussed. Some test results are given and compared with calculations.

The Construction of a Revised Temperature-Entropy Chart for Air and Its Application to Explosive-Combustion Studies, by Prof. H. A. Everett, Mem. ASME, Pennsylvania State College, State College, Pa. 1948 ASME Annual Meeting paper No. **48—A-97** (mimeographed).

This paper presents the manner in which the thermal properties of air were compiled and plotted on temperature and entropy as co-ordinates to produce a composite diagram or chart, also additional curves evaluating intrinsic energy and enthalpy for various temperatures and pressures.

There are included typical illustrative examples showing the application of the chart to the solution of some problems arising in the analysis of combustion phenomena occurring in internal-combustion engines such as rate of burning, thermal efficiency, and the influence of some such controllable variables as duration of combustion.

A Theoretical Investigation of Detonation in the Gasoline Internal-Combustion Engine, by Major Frank A. Bates, Jr., Armed Forces, Special Wnps, Albuquerque, N. Mex., and Captain J. L. Quinnelly, Jun. ASME, Fort Knox, Ky. 1948 ASME Annual Meeting paper No. **48—A-103** (mimeographed).

Detonation in the internal-combustion engine is a phenomenon which cannot be viewed with the naked eye. The process of detonation is one that is complex and difficult to understand unless certain limiting factors are placed upon it at the outset.

It was felt that by a theoretical analysis of detonation a sufficient background of knowledge could be gained from which future investigations could be carried on.

The effect of detonation on the gaseous mixture was set up as the problem which the investigators attempted to solve. It is believed that the best picture of what was taking place inside the cylinder chamber could be obtained by making an analysis which would show the pressure, temperature, and volume of the gaseous mixture at any given percentage of detonation; this includes both the normally burned and detonating portions.

The combustion of the detonating portion occurs so rapidly that there is insufficient time for pressure equalization. These gases expand very quickly and compress the remaining portions of normally burned gases. Once detonation occurs and the gases have started compression and expansion, the inertia of the mass of the gas causes the gases being compressed to be compressed beyond their equalizing pressure and those gases expanding to expand beyond their equalizing pressure. This mass vibration of the gases continues until damped out. The scrubbing action of the moving gases on the cylinder walls results in better heat transfer to the cooling medium and thus a power loss to the engine. This analysis is concerned with the pressures, temperatures, and volumes of the normally burned and detonating portions at the end of the first swing of mass vibration of the gases. Further, it was attempted to determine the limiting pressures and temperatures encountered when the percentage detonation is varied from 0 to 100 per cent.

Production Engineering

The Commercial Weldery—A New Service and Tool for Industry, by Kenneth F. Ode, Trackson Company, Milwaukee, Wis. 1948 ASME Annual Meeting paper No. **48—A-92** (mimeographed).

While welding as a manufacturing tool has existed for about 30 years, its commercial feasibility became apparent only about 15 years ago. In the period from 1933 to 1943, weld-rod consumption per ton of finished steel produced, increased over 10 times.

By the simple application of an electric current, two pieces of metal are joined into an integral part with a speed and freedom from limitations never before possible. Metal can be placed where design requirements indicate it is needed. Alloy steels with their specific properties are used only where service demands, and surfaces are given overlays of hardened steel where abrasive-resistant qualities are recommended. All of this is accomplished by equipment investments far below that required using the older processes of fabrication.

Simplification and elimination of parts is possible by the use of welded design. Many types of structures can be made integral that would be impossible as casings or forgings without the use of excessive machining, bolting, and keying. The use of composite structures, that is, the joining of steel plate with steel castings, offers a fertile field of development. Many structures have sections that can be most economically designed as steel castings, while the other parts of the structure are better adapted to place construction.

Government, private, and industry-operated schools have turned out thousands of operators. Private research by industrial companies and universities are solving welding problems and advancing our knowledge in this field so that America in its postwar development can use this process to its fullest extent.

Railroads

Practical Considerations in Railroad Work, by E. H. Weston, Mem. ASME, Chicago and Northwestern Railway System, Chicago, Ill. 1948 ASME Annual Meeting paper No. **48—A-77** (mimeographed).

Successful press-fit work is one of the few present-day fields drawing its vitality mainly from accumulated personal experience. The science of making a press fit is distributed throughout the ranks of the old-line, long-time machinists. Each machinist has his own combination of factors, resulting in a satisfactory press fit. Each man is sure that his method is the most infallible, and his guarded secrets are revealed only to his intimate co-workers and proteges.

With the gradual disappearance of the long-time steady journeyman mechanic and with his replacement by setup helpers, ship people and engineers find themselves turning to the mechanical handbooks for the rules governing press-fit practice. The mechanical handbooks, however, give nothing but empirical data. These data give the results of certain actions, but little information toward developing why such actions were taken.

The science of making press fits is described and discussed with recommendations for obtaining the best in press fits.

Progress in Railway Mechanical Engineering, 1947–1948, Report of Committee RR-6 Survey. 1948 ASME Annual Meeting paper No. **48—A-126** (mimeographed; to be published in MECHANICAL ENGINEERING).

Adoption of the Diesel-electric locomotive by the railroad continues to be the outstanding phase of motive-power development.

An increasing number of roads have announced plans for complete dieselization of all their services, or of important divisions of their lines. Some of the smaller roads already have reached this goal.

The Canadian lines have commenced to use Diesel-electrics in road services, but because of a fuel situation (price and supply) differing from that in the U.S.A., these railroads are proceeding more slowly toward extensive dieselization.

While a few new designs have made their appearance during the year, Diesel-electric locomotive production has become standardized to the extent of quantity production of "frozen" basic designs which have been accepted by the railroads as practical, well-proved motive-power tools. The success attained by the relatively low-powered single-operating unit, operated in combinations of one to four cabs, with consequent high weight on drivers for the resultant locomotive, has discouraged any widespread development of high-horsepower single-cab locomotives.

Although the conventional steam locomotive seems to have been relegated to second position in so far as new motive-power orders are concerned, several requisitions for new steam power were placed by domestic railroads in the past year. As of September 1, 1948, there were 1510 Diesel-electric locomotives and 116 steam locomotives on order by the Class I Railroads of the United States. The so-called "coal" roads continue to acquire and to use new steam power with considerable success.

Extensive electrification programs are under consideration in some of the Asiatic countries, notably India and Siam, in conjunction with the development of native natural resources for the production of electric power. It is reported, although without details, that extensive electrification of some of the lines of the USSR is being undertaken.

Considerable apprehension has been expressed in some circles as to the assurance of future oil supplies for railway motive-power use, and the apparently limited supply, with an ever-increasing number of uses calling for oil, has quickened interest in the coal-using forms of motive power.

Efforts to utilize the steam turbine as a prime mover for railway motive power, principally in coal-burning units, are still being made in the United States.

Development work aimed at the utilization of the gas turbine in both the coal-burning and the oil-burning forms continues at a moderte rate. No new locomotives of this type have taken to the rails during the past year, either in the U.S.A. or abroad.

Solid-Type Journal Bearings in High-Speed Freight Service, by E. S. Pearce, Mem. ASME, Railway Service and Supply Company, Indianapolis, Ind., R. J. Shoemaker, Mem. ASME, Magnus Metal Corporation, Chicago, Ill., and I. E. Cox, National Bearing Division, American Brake Shoe Company, St. Louis, Mo. 1948 ASME Annual Meeting paper No. **48—A-128** (mimeographed).

The term "High-Speed Freight" implies the shortening of elapsed time between terminals. This would require higher top speeds and more rapid acceleration.

High-speed freight must be obtained within the practical limits of cost and over-all economics of railroad operation. If high-speed freight is not to be restricted as to interchange, special equipment, and special movements, then all freight equipment must be equally adaptable to high-speed operation as and when the occasion arises.

For high-speed freight, bearings are involved in the elements of: less resistance per train; dependability and safety; and economy in first cost, maintenance, and weight.

This paper encompasses the operating conditions involved in the selection of the bearing equipment in high-speed freight; the performance of the solid-type bearing, the potentials of future development, and the superior adaptability of the solid-type bearing to the economics of railroad operation.

Heat Transfer

Heat Transfer to Liquid Metals Flowing in Asymmetrically Heated Channels, by W. B. Harrison, Oak Ridge National Laboratory, Oak Ridge, Tenn., and J. R. Menke, Mem. ASME, Nuclear Development Associates, Inc., New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-51** (mimeographed).

Heat transfer to a fluid in turbulent flow between two plane parallel walls is discussed for the case of an asymmetrically heated system in which the entire heat flux is transferred at one of the walls and no heat passes through the other. An annulus for which the ratio of diameters approaches unity may approximate this case in the limit. At low Peclet numbers, Nusselt numbers calculated in the manner outlined are roughly 50 per cent of the values presented by Dr. R. C. Martinelli for symmetrical systems. At high Peclet numbers, asymmetrical-system calculations are about 67 per cent of the symmetrical-system calculations.

Suggestions have been made regarding an experimental approach for finding the variation of eddy diffusivity across a flat channel especially in the vicinity of the center line and also for simply determining heat-transfer coefficients in asymmetrical systems.

This paper is not considered to be complete in itself, but only a brief extension of the work presented earlier by Dr. Martinelli.

Errors in High-Temperature Probes for Gases, by E. Marston Moffatt, Airflo Instrument Company, Glastonbury, Conn. 1948 ASME Annual Meeting paper No. **48—A-52** (mimeographed).

This paper sums up the theoretical background for calculating temperature-probe errors and discusses uncertainties in the theory. These results are applied to analyzing some typical errors incurred with temperature probes used in high-temperature gas streams. The errors are calculated for several different types of probes which can be divided roughly into two classes: simple bare probes and shielded probes. The former type are known to be subject to large errors at high temperatures and their readings are frequently corrected theoretically. Errors in the corrected as well as the uncorrected readings are discussed. The shielded types are commonly used without any corrections and some probable errors in these uncorrected readings are calculated. The emphasis is on probable errors inherent in "corrected" as well as uncorrected temperatures with existing instrumentation.

Rates of Fouling and Cleaning of Unfired Heat-Exchanger Equipment, by J. H. Weiland, Jr., R. C. McCay, and J. E. Barnes, The Texas Company, Port Arthur, Texas. 1948 ASME Annual Meeting paper No. **48—A-112** (mimeographed).

This report presents heat-exchanger performance data and describes exchanger cleaning procedures during the period 1943–1947 at the Port Arthur Works of the Texas Company.

The performance data are presented in the form of tables and graphs which show the rates of over-all heat transfer and exchanger fouling, and the changes in these rates after bundle cleansing.

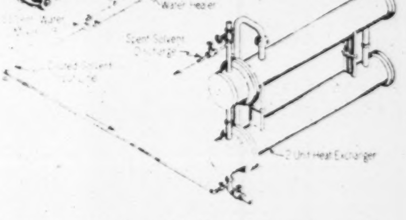
In an effort to provide useful data on fouling and methods of cleaning of unfired heat-exchange equipment, data were developed from test runs and survey periods. The types of heat-exchange services which were considered are: (1) Cycle fuel-oil-heated naphtha reboilers; (2) depropanizer reflux condensers; (3) absorption oil coolers; and (4) gas-oil catalyst slurry exchangers.

Calculated values of the heat duties, over-all heat-transfer coefficients, film resistances, and total fouling resistances are given. Graphical presentations of the over-all heat-transfer coefficients and fouling resistances are presented. In all cases, only data with comparable operating conditions were used. The flow rates and entering temperatures, as well as unit conditions, were maintained as constant as possible throughout the report data.

Chemical Cleaning of Heat-Exchange Equipment, by C. M. Loucks, Dowell Incorporated, Cleveland, Ohio, and C. H. Groom, Jun. ASME, Dowell Incorporated, Tulsa, Okla. 1948 ASME Annual Meeting paper No. **48—A-113** (mimeographed).

It is logical to expect heat-exchange surfaces to experience some degree of fouling. When the fouling becomes serious enough to cause appreciable loss in efficiency of heat transfer some measure of corrective maintenance is necessary. This paper concerns the use of chemical solvents for removing the offending deposits and restoring the equipment to satisfactory performance.

The successful and economic application of solvent cleaning depends upon a number of factors, namely, the deposits, the metals in the unit to be cleaned, the solvents available, and safe operating practices. These factors are discussed as they influence solvent cleaning, and the methods of application are described by citing experiences with solvent cleaning in various industries.



TYPICAL HOOKUP FOR THE CHEMICAL CLEANING OF HEAT-EXCHANGE EQUIPMENT

The Mechanical Cleaning of Fouled Heat-Exchanger Tubes, by A. John, Jun. ASME, Thomas C. Wilson, Inc., Long Island City, N. Y. 1948 ASME Annual Meeting paper No. **48—A-114** (mimeographed).

During the past ten years many additional plant processes have been developed utilizing heat exchangers more and more extensively. Thus the incidence of fouling troubles greatly increased and since production was a byword its incentive applied to tube cleaning as well. This created the impetus to concentrate on the development of a special mechanical tube cleaner particularly one to remove very heavy scale deposits and also to open up plugged tubes. Many improvements of mechanical-cleaning methods manifested themselves during this period and ultimately a high speed, direct drive, scavenging drill-type cleaner was successfully developed and marketed.

One tube cleaner that has been developed and that has proved popular is known as the outside suspension type and in appearance resembles an electric drill. It consists of a high-powered air motor operating outside of the tube bundle transferring power through a hollow rotary shaft to which is attached a special drill bit, brush, or other suitable accessory. The hollow rotary shaft provides a means of introducing a scavenger such as air, water, or steam under pressure direct to the point of cutting and serves to soften the fouled matter, wash away the debris, and keep the cutter bit cool.

Electrically driven flexible-shaft cleaners also have been found satisfactory for use in confined quarters or where compressed air is not readily available. This type of cleaner is popular for cleaning certain process calandria units and the vertical open-head shell and tube condensers in refrigeration plants. It may be well to point out that in an ammonia-compressor plant, enormous savings in electric power used for compression are not only possible but an actual fact. It has been ascertained that even after hand cleaning a substantial amount of the deposit remains and that a follow up with the mechanical cleaner removes enough additional deposit to reduce the ammonia head pressures between 10 and 25 pounds.

Experience with mechanical cleaners has indicated that large savings in capital investment as well as the obtainment of increased process efficiency are attainable. The usual maintenance crew is sufficiently experienced to handle mechanical cleaners which can be procured at a very moderate cost. Consequently many plants have established this method as the preferred one, particularly for immediate "on-the-spot" service and also as spare emergency-cleaning equipment. Experience also indicates that these cleaners usually satisfactorily perform their task long before other methods are started. For the opening up of completely plugged heat exchangers mechanical cleaning is the only method available barring retubing. At present there is no known method of pickling, lancing, or otherwise clearing out plugged heat-exchanger tubes.

Scale Formation and Control in Compression Distillation of Sea Water, by John J. Campobasso, E. B. Badger & Sons Company, Boston, Mass., and Allen Latham, Jr., Mem. ASME, Arthur D. Little, Inc., Cambridge, Mass. 1948 ASME Annual Meeting paper No. **48—A-115** (mimeographed).

Various principles which have been used to combat the formation of scale in sea-water distillation equipment are outlined briefly. The object of this paper is to present data on the results obtained through the application of some of these principles to the removal or prevention of scale in the compression type of distillation equipment. This form of still was widely used during the war for military water supply and is now in use in several marine and industrial installations. All of the data reported were taken on compression stills which used a short vertical tube, natural circulation, calandria type of condenser-evaporator with boiling inside the tubes.

The paper reports that the rate of scale formation in current models of compression sea-water distillation units is such that 200 to 300 gal of distillate can be produced per square foot of evaporation surface before it is necessary to clean the surface; periodic treatment with solutions of sodium acid sulphate or hydrochloric acid can be used to obviate the need of mechanical cleaning; and vacuum operation to give boiling temperatures of 150 F offers a good possibility for prevention of any significant formation of scale.

Cleaning Tubular Heat Exchangers, by P. F. Dougherty and C. H. Brooks, Sun Oil Company, Philadelphia, Pa. 1948 ASME Annual Meeting paper No. **48—A-116** (mimeographed).

This paper covers various methods available for cleaning tubular heat-transfer equipment, with particular emphasis on the use of an emulsifying oil for "in-place" cleaning, and on the use of sandblasting. The relative merits of the in-place and the mechanical methods are outlined, as well as the factors to be considered in selecting a particular procedure for a given application.

The cleaning methods for tubular heat transfer equipment fall into two general classes. The first class consists of those methods which perform the cleaning without dismantling the equipment, by means of the circulation of a solution which chemically and/or physically removes the fouling material. The second class includes all those methods where the equipment is partially or wholly dismantled, and the fouling agent removed by a purely mechanical means.

The adaptability of the in-place methods must be determined by physical and chemical examination of the fouling substance. Laboratory solubility tests must also be made of the material. A plant scale test under close supervision should then be made, if it is found in the laboratory that a significant portion of the fouling material is soluble.

If no suitable method is found for cleaning in place, one of the various mechanical methods must be used.

Fouling Rates and Cleaning Methods in Refinery Heat Exchangers, by Robert C. Butler and William N. McCurdy, Standard Oil Development Company, Linden, N. J. 1948 ASME Annual Meeting paper No. **48—A-117** (mimeographed).

Fouling of exchangers and other refinery equipment costs refineries considerable sums each year in decreased capacity and lost heat, in addition to the actual cost of cleaning the equipment. Refinery experiences with rates of fouling, means of reducing fouling rates, and methods of cleaning exchanger equipment in various services are studied in determining the correct equipment design for new plants and in solving fouling problems in existing plants.

The three phases of heat-exchanger operation and maintenance which are covered in this paper are as follows:

Rate of fouling. Operating data from exchangers in various refinery services are used to correlate rate of fouling with time.

Reduction of fouling. The use of pressure and temperature control, blanketed feed tankage, feed stripping, and injection of additives as means to reduce fouling rates is discussed. Results obtained by refineries are given.

Cleaning methods. The mechanics and effectiveness of some methods of cleaning heat exchangers are discussed. The methods described are sandblasting, mechanical cleaning, and chemical cleaning.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Engineering Training

COMMENT BY KURT F. WENDT[1]

Sporadic attempts to improve university-industry co-operation in the matter of engineering training[2] have met with some success, but sustained effort on the part of both industrial management and university faculties is required if substantial progress is to be realized.

The proposal that a joint university-industry committee, provided with adequate time and funds for thorough analysis, be assigned to study the problems and create plans for improved relations merits careful consideration. Such a group could serve to define clearly the special requirements of industry and point out the most likely and desirable means for meeting these needs. The author implies that major changes in educational curricula would be required, beginning at the secondary-school level to accomplish desirable objectives in a reasonable period of training. Difficult adjustments in our secondary schools could be secured only with the close co-operation and enthusiastic support of the school boards and the educational associations affected. Such radical modifications of the existing pattern would need to be programmed and instituted carefully, or at least indorsed, by a majority of the recognized colleges in the country, to insure acceptance by prospective students. Employees, the public, faculties, school boards, administrators, and politicians, as well, would need to be educated and "sold" on such a venture. Difficult? Yes! Impossible? Probably not if a group having the confidence of both professional educators and industry can agree.

Many of the author's proposals for introducing current industrial problems and work into the classroom and laboratory are not feasible under existing conditions. Whether or not they could be adopted under a new program of development requires careful analysis, especially with regard to the economic and time factors involved. Most universities are attempting some steps in the direction proposed at the graduate level, but find themselves limited by space, time, and cost requirements. Perhaps a committee study could solve some of the vexing problems encountered—at least it could bring to all interested parties a clearer understanding of desirable objectives and a more sympathetic approach toward mutual understanding.

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[1] Professor of Mechanics and Associate Director of the Engineering Experiment Station, The University of Wisconsin, Madison, Wis.

[2] "Engineering Training—Relations of the University and Industry in Developing Engineers," by W. P. Schmitter, MECHANICAL ENGINEERING, vol. 70, 1948, pp. 743–746.

Aircraft Hydraulic Packings

COMMENT BY H. A. ZIMMERMAN[3]

The summary[4] of the types of packings available and the history of usage recently published should prove useful. Some points in the discussion of the T-ring packing, however, warrant further clarification.

The writer was connected with The Weatherhead Company in an engineering capacity during the time, late in 1940 or early in 1941, that Elmer F. Jackman first suggested the idea of the backup or guard rings for aircraft hydraulic applications. Mr. Jackman was associated with that company at the time to further development of a water-pump shaft seal made up entirely of phenolic disks. The hydraulic-packing design was suggested as a solution for sealing difficulties encountered in landing-gear retract cylinders, then being produced for Air Corps aircraft. The simplicity of the installation was realized before the O-ring, covered by the Christensen patent, was known to us.

It fell to the writer's lot to supervise development-testing of this packing, to attempt its introduction to the services, and to introduce it to all of the major aircraft manufacturers. As has been pointed out, the initial inspiration for this invention came from an analysis of problems encountered in producing properly functioning cylinders. Similar problems were being solved at other places independently, notably Chance-Vought Aircraft, through employment of the Christensen O-ring. Simultaneously, standardization was being emphasized. We presented preliminary data to the Air Materiel Command in October, 1941. No action was taken, however, until January, 1942, when improvement in O-ring design and compounding was reported as being satisfactory for the 1500-psi systems then being used most widely.

These points are mentioned because the statement in the paper glosses over the real purpose of the "guard" rings and says: "This design is supposed to prevent the twisting of the ring," apparently referring to a protection against "spiral" failure. No such thought was in the mind of the inventor or those who assisted his development! The purpose of the guard rings (and there are two on each side of the leg of the T, rather than one as shown in Fig. 7 of the paper), was to eliminate clearance. The rings, which are split, are made to fit snugly in the cylinder bore, or on the rod, depending upon the application. By the action of the central plastomer under pressure they are held against the surface to be sealed and eliminate the three clearance situations:

(*a*) Design clearance.
(*b*) Temperature-variation clearance.
(*c*) Pressure-effect clearance.

When 0.008-in. maximum clearance was stipulated for 1500-psi applications (without eliminating all trouble), we were successfully running tests up to 4500 psi with 0.020 in. clearance. This was possible because the backup rings always prevent extrusion of the sealing portion of the packing.

They performed another function. Being fairly hard, they acted as scraper rings and kept abrasive matter from cutting the central, or sealing, member.

Spiral failure has been referred to. Not only is the T-ring packing inherently free from this sort of problem, it will not leak if deliberately cut to simulate the type of failure known as spiral in an O-ring. Spiral failure first attained serious attention in the spring of

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[3] Sales Manager, The Steel Improvement & Forge Company, Cleveland, Ohio.

[4] "Aircraft Hydraulic Packings—Factors Influencing Their Performance," by LaVerne E. Cheyney and T. J. McCuistion, MECHANICAL ENGINEERING, vol. 70, 1948, pp. 675–679.

1944, as a result of a large number of reported service failures. Trial installations of T-rings were made in the nosewheel retract cylinders of P-38's, and the bomb-bay cylinders of B-24's at Santa Rosa Air Base and March Field, respectively. During the March Field tests, it was established that if the synthetic seal ring were cut through, the design of the packing when installed was such that leakage would not occur. This characteristic was later proved in laboratory endurance tests. It is unfortunate that this clever design has not received more and better attention so that its acceptance might be a credit to the memory of the very fine man whose brain child it was.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Education for Professional Responsibility

EDUCATION FOR PROFESSIONAL RESPONSIBILITY: A Report of the Proceedings of the Inter-Professions Conference on Education for Professional Responsibility held at Buck Hill Falls, Pa., April 12–14, 1948. Carnegie Press, Carnegie Institute of Technology, Pittsburgh 13, Pa., 1948. Cloth, $5^1/_2 \times 8^1/_4$ in., 207 pp., $3.

REVIEWED BY DONALD B. PRENTICE[1]

IN APRIL, 1948, an interprofessions conference was held at Buck Hill Falls, Pa., under the sponsorship of the Carnegie Corporation of New York, N. Y. "Education for Professional Responsibility" is a record of that conference. Approximately one hundred individuals associated with education at the professional level, and representing in nearly equal numbers the divisions of law, medicine, theology, engineering, and business, spent three days together in almost continuous session. Prepared discussions on objectives, content, method, and social and humanistic aspects of professional education were presented in each of the five fields and a fair amount of time was allotted to general comment from the floor. Doubtless the small group arguments which continued after the close of the several sessions also developed many interesting ideas. However, this material was not recorded and the present volume includes the prepared addresses only.

Eighteen addresses were scheduled for the three days and more than brief reference to each is impossible if this review is to be kept to reasonable length.

On the opening day discussions dealt with the objectives of professional education. Dean David of the Harvard School of Business Administration reduced his program to two objectives: (1) to give students the necessary background of present knowledge, to stimulate them to continued study, and to develop the "artistic" skills needed to apply their knowledge; and (2) to add to the body of knowledge through research.

Robert D. Calkins of the General Education Board, speaking at the same session, emphasized the intricacies of modern business and its complicated operational problems. "The problem before us is not so much the problem of preserving the existing system as it is the problem of demonstrating our capacity to operate the system. . . . ."

Professor Fuller of the Harvard Law School presented four possible objectives of legal education; (1) giving the student *knowledge*, (2) imparting *skills*, (3) exposing him to *great minds*, or (4) developing an understanding of *processes*. The fourth objective was elaborated and had Professor Fuller's endorsement.

President Rogers[2] of Brooklyn Polytechnic Institute cited the 1940 and 1944 reports of the Society for Engineering Education on Aims and Scopes of Engineering Curricula and discussed the extent to which engineering education falls short of its goals. Some pertinent suggestions for closing the gaps were presented.

President Van Dusen of Union Theological Seminary admitted the conservatism of the divinity schools; quite properly, without apology. He had more difficulty, however, with the problem of diversity. Perhaps the quoted aims of ministerial training, "sound learning, true piety, enlightened experience" are sufficient; detailed statements would increase rather than decrease the argument.

Two brilliant philosophical discussions from the "naturalist" and "relative objectivist" positions by Prof. Homer Smith of New York University and Prof. Theodore Greene of Yale University, respectively, conclude the section of the volume devoted to "objectives." These discussions are brief and yet so comprehensive that to attempt summaries seems unwise and certainly would be most difficult.

Session II was devoted to content and method of professional education. Professor Culliton of Harvard spoke for business, Dr. Fairbanks of the Institute for Pastoral Care for theology, Professor Llewellyn of Columbia for law, Dr. Means of Harvard and Professor Cockerill of the University of Pittsburgh for medicine, and Professor Teare of Carnegie Institute of Technology for engineering. All of these speakers emphasized the importance of case or problem work in training and there seemed general agreement that the selection of material of suitable difficulty to sustain interest without exceeding student capacity to absorb was the crux of method. Incidentally the development of ability to adjust to social environment was stressed as an important by-product of professional training.

Although the addresses presented on the third day of the conference fill only one fourth of the volume, they are probably as important as all the others together for they attack the major problem for which the sessions were held. The significant contributions which professional men and women can make to society, in addition to those which derive from their technical skills, are based on the "social and humanistic aspects" of their lives. Whatever stimulation of these relationships can be supplied during the years of study is, therefore, an immensely important phase of education.

The opening remarks of Dean Vanderbilt of New York University, who is also a circuit-court judge in New Jersey, cited the unwillingness of professional people to accept civic responsibilities, particularly in politics. Jury duty and even the basic act of voting are performed grudgingly or dodged. Dr. John Romano, professor of psychiatry at the University of Rochester School of Medicine, suggested that unbalance in training might explain lack of interest in social matters. Courses in chemistry, physics, anatomy, physiology, and similar subjects for physicians are far more thorough, and necessarily so, than courses in sociology and psychology. Dr. Romano then discussed at length physician-patient relationships and so limited the social and humanistic aspects of the medical profession.

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[1] Director, Scientific Research Society of America, New Haven, Conn. Fellow ASME.

[2] "The Education of the Engineer," by Harry S. Rogers, MECHANICAL ENGINEERING, vol. 70, November, 1948, pp. 895–897.

Dean Katz of the University of Chicago Law School suggested that research on problems of public policy, conducted in law schools and shared by students, offered valuable training in human relations. Study of the "nature of moral, and therefore of legal, responsibility" should contribute to the development of social consciousness.

Dean Muelder of Boston University School of Theology continued the discussion with reference to the study of social ethics. He pointed out that "the ministry makes contact with personal counseling, family counseling, social work, labor relations, business associations, social legislation, civil rights, housing problems, race relations and many others. Unless the minister is well-grounded in integrated social studies his work in the community relations field is likely to be either superficial, doctrinaire, fragmentary, or merely sentimental."

The final discussion and, in effect, a summary of the sessions was given by Dr. Elliott Dunlap Smith,[3] provost of Carnegie Institute of Technology and organizer of the conference. Dr. Smith argued for full recognition of social and humanistic studies on a p [illegible] with technological courses, and fo [illegible] eaching the former as well as the lat [illegible] y the presentation of concrete situ [illegible] the case method. He favored, [illegible] simultaneous rather than seque [illegible] eatment, as otherwise the studen [illegible] ural interest in his professional s [illegible] cts may exclude the earlier general college courses from affecting his habits of life.

As might well be expected the formal discussions of the conference were but slightly related. The informal conversations, between sessions, bridged the gaps. This volume may be difficult reading, therefore, and appears as a series of unconnected essays rather than a consecutive treatment of a central theme. Participants in the conference had more sense of continuity than is possible for the readers of the report. In fact the blending of the series was remarkable when one considers that five widely varying professions participated. Normally there is little in common between law, medicine, theology, engineering, and business.

The conference and the resulting publications are valuable contributions toward unity of effort in the development of social responsibility where it must be developed and practiced for the good of humanity, in the professional life of the nation. It is significant for engineers that no fundamental differences were evident between the aims and methods of those who train students for their profession in undergraduate years and the objectives of those who require baccalaureate degrees for admission to graduate professional courses.

Management-Union Arbitration

MANAGEMENT-UNION ARBITRATION: A Record of Cases, Methods and Decisions. By Maxwell Copelof. Foreword by John R. Steelman. Harper and Brothers, New York 16, N. Y., 1948. Cloth, $6^{1}/_{4} \times 9^{1}/_{4}$ in., 345 pp., $5.

REVIEWED BY CHARLES W. LYTLE[4]

THIS reviewer has balked at the suggestion that arbitration has reached, or ever will reach, the status of a science, but this thorough treatment of the subject converts one to the belief that arbitration has developed a mass of experience which might be likened to the common law. The author may not consider himself a Blackstone, but certainly he has achieved something like a codification of the precedents, and commonsense rules within which justice, or at least mutual acceptance, is most likely to be attained. This result is due not only to the author's exceptional experience in arbitration, but fully as much to his ability to put his knowledge in order and to analyze it. Thus he selects from hundreds of cases 162 questions that are likely to recur, arranges them in a natural order and draws conclusions as to how they should be met. Such guidance from a seasoned arbitrator should be very helpful to those who are less seasoned in this difficult office. For instance, one of the first questions he raises is quite a poser when an arbitrator meets it without warning, viz., "the right of either party to take the dispute to arbitration is itself a proper subject for arbitration." This he thrashes out so that a reader will know how to get over that hurdle without discrediting himself in the first half hour of a hearing. We hasten to add, however, that this kind of instruction is not presented solely for arbitrators. "The summaries of these cases can contribute, I hope, to a better understanding of arbitration proceedings and how they should be conducted. To provide such information to management, to labor organizations, and to students of industrial relations, is the sole purpose of this book." Of course any case material loses something when taken out of its original setting and is in danger of being about as interesting as a solved crossword puzzle. This pitfall has been remarkably well bridged and most of the cases are universal enough to evoke interest from any who are likely to take part in arbitration.

Most arbitration hearings are concerned with knotty problems which root back into everything that composes industry. Consequently, one who does much arbitrating takes a most intensive and in time extensive refresher course in management. As an outsider the arbitrator is bound to miss some of the local intricacies, but his aloofness has advantages in open-mindedness and in breadth of view. Mr. Copelof has been getting this kind of education for years and now boils it down so that his readers can get much of it on easier terms. It has not been generally recognized that policy making is increasingly dependent on what happens at the bargaining table, and what happens to the last-ditch stands before an arbitrator, but the issues classified and clarified in this book will bear out this implication. Thus the book is worthy of use in training future managers and future union leaders, on the job or in college.

One of the chapters we think most timely is headed; Preparation and Presentation of Cases. We mention this because in our own relatively brief experience we have observed that rarely does either side make the most of the possibilities. Management is frequently handicapped because it is not sure how the union will proceed. The union is usually handicapped by not having experts on the management techniques. Both sides are inclined to turn their cases over to lawyers who can't comprehend what the shop terms mean. In short those who know what it is all about must educate all the others during their short periods on the stand, or ask for an exchange of briefs which delays the decisions. Repeated arbitrations do eventually teach both sides something about preparation and presentation, but many might still benefit by studying this book.

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[3] "The Education of Professional Students for Citizenship," by E. D. Smith, MECHANICAL ENGINEERING, vol. 70, 1948, pages 959–962.

[4] Professor of Industrial Engineering, New York University, New York, N. Y. Mem. ASME.

Like all wide-scope books this one has its limitations and we suspect they reflect the limitations of arbitration if not of all arbitrators. These shortcomings should not be surprising. Controversial questions arise in fields that are semi-technical and must be decided promptly whether the arbitrator has or has not a thorough understanding of the principles and customs involved. For instance, many issues are within the fields of task setting, job evaluation, wage incentives, etc., all of which are now elaborately refined. Ideally such issues should be so well handled by management through enlightened policy and by labor through negotiation, that they do not get into high dispute. Actually such issues do get into high dispute and all an arbitrator is supposed to do is to give his interpretation of how the existing agreement applies. In practice he may be called upon to go beyond that. Agreements are sometimes faulty even when they are phrased by lawyers. Every arbitrator has been plagued by loose or ambiguous statements. Mr. Copelof doesn't say so, but this situation suggests the advantage of selecting particular arbitrators for particular issues, rather than selecting one arbitrator for a period of time.

The author gives a chapter on union rights and prerogatives in which management rights and prerogatives appear incidentally. We think there should have been another chapter devoted primarily to management.

Despite these criticisms we endorse the book under review as the best one written on this important subject and conclude that Mr. Copelof has thereby helped to sell arbitration despite his disavowal of that aim.

Early Days of Oil

EARLY DAYS OF OIL: A PICTORIAL HISTORY OF THE BEGINNINGS OF THE INDUSTRY IN PENNSYLVANIA. By Paul H. Giddens. Princeton University Press, Princeton, N. J., 1948. Cloth, $8^{1}/_{2}$ × 11 in., illus., 150 pp., $6.

REVIEWED BY CHARLES F. FOELL[5]

THIS is a picture book describing in carefully selected half-tones and line-cuts the early days of oil in the Pennsylvania field; text matter is rather severely limited, being chiefly caption material for the illustrations. The material is of necessity confined to places, things, and people—places like Oil City, Titusville, numerous other localities (many long since shadows once their wells ran dry) along Oil Creek and neighboring runs, where oil was discovered; things like the refineries, transportation by wagons, streams, rail tank cars, and the first crude pipe lines, and incidental events of daily living and the conduct of one's public and private affairs; men such as Drake, Kier, "Coal Oil" Johnny Steele, Van Syckel, Harley, the brothers Roberts, McKinney, the original Rockefeller, Pew, Archbold, and a host of others too numerous to mention.

This is a book to be perused for pleasure. Its very nature prevents a cohesive coherent train of historical facts and other statistical data. But to all interested in petroleum, an industry so intimately wrapped up with America's industrial development, "Early Days of Oil" can offer many opportunities for pleasant scanning, for five minutes at a time or for an hour.

Mr. Giddens has drawn heavily on the Mather collection of photographs in compiling this volume. John A. Mather was the unofficial but exceedingly active photographer of the Pennsylvania oil regions. Between 1860 and 1892 he recorded by camera more than 16,000 views, but then suffered the loss of all but about 3000 in the catastrophic fire and flood that swept Titusville, along with other communities, in the latter year.

The rescued negatives, major source of material for this volume, now rest in Drake Well Memorial Park, near Titusville.

The author appears to have made a most interesting and varied selection. In addition, typography, format, and printing have been combined in such a manner as to produce a volume of potential value to all those genuinely interested in Americana. A short index and a list of photographs and sources also appear.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

The Nature of Patentable Invention

THE NATURE OF PATENTABLE INVENTION; its attributes and definition. By John E. R. Hayes. Addison-Wesley Press, Inc., Cambridge 42, Mass., Second Edition, 1948. Cloth, $5^{3}/_{4}$ × 9 in., 187 pp., $5.

REVIEWED BY EDWARD GOTTLIEB[6]

THIS book is not a textbook on patents, nor is it a patent law book. It contains no illustrations or stories of inventions. It is seriously written and earnestly attempts to point out the nature of a patentable invention in two ways, namely (1) by quoting numerous passages from court decisions dealing with the nature of invention, and (2) by discussing each quotation and, with sound analytical reasoning, analyzing the nature of invention.

The book is highly interesting because it covers more than 150 inventions and court cases, many of them of historical fame. A few of the cases covered are the Aspirin case, the Barbed Wire patent, the Incandescent Lamp patent, Marconi's Wireless, the Telephone cases, the Weed Chain Tire Grip cases, etc. None of these cases are discussed in detail as the author doggedly sticks to his subject of analyzing and attempting to disclose the nature of patentable inventions. At times the negative approach is used, as for example by showing famous inventions which were ruled as not patentable such as Dr. Morton's use of ether as an anaesthetic; the case of the eraser on a pencil (Reckendorfer v. Faber), etc.

The subject of the nature of a patentable invention is not an easy one to understand for the simple reason that it is difficult to understand why any valuable invention should be ruled as unpatentable because of its nature. However the law recognizes many kinds of inventions as being patentable and others as being nonpatentable. The author covers this subject thoroughly.

Consideration is given to the mental concept of invention, to the modes of physical attainment, to various considerations pertaining to new and useful results conceived of in an invention, and similar topics. So-called general rules of law are applied to many cases. Exceptions to the general rules are given. In addition various other important points are covered.

This book should be of exceptional value to engineers and others having the ability to concentrate and grasp a purely technical subject. It will be of value to those concerned with new inventive developments provided they have the patience to carefully read the book and the ability to understand a deceptively simple subject.

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[5] Technical Writer, Editor, Socony-Vacuum Oil Co., New York 4, N. Y. Jun. Mem. ASME.

[6] Patent Attorney, New York, N. Y. Mem. ASME.

Books Received in Library

Business, Legal, and Ethical Phases of Engineering. By D. T. Canfield and J. H. Bowman. McGraw-Hill Book Co., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, $6 \times 9\frac{1}{4}$ in., 358 pp., diagrams, charts, tables, \$4.50. This book is a revision and a combination of "Business Administration for Engineers" and "Legal and Ethical Phases of Engineering." It provides engineering students with detailed discussions of various situations within these fields which they are likely to encounter in practice, and is general enough for any type of engineer. Illustrative examples and questions at the end of each chapter are such as are likely to be experienced by engineers.

Company Wage Policies. (Industrial Relations Section Research Report Series: No. 77.) By R. A. Lester. Princeton University, Princeton, N. J., 1948. Paper, $6 \times 9\frac{1}{4}$ in., 45 pp., \$1.50. This brief study is the result of a survey of the processes by which wage policy is determined by some 100 representative manufacturing companies in the United States, small and large. Topics dealt with include the basis for plant level of rates, factors in wage-level charges, and the consequences of intercompany uniformity.

Conversion of Petroleum, Production of Motor Fuels by Thermal and Catalytic Processes. By A. N. Sachanen. Second edition, revised and enlarged. Reinhold Publishing Corporation, New York, N. Y., 1948. Cloth $6 \times 9\frac{1}{4}$ in., 602 pp., diagrams, charts, tables, \$11. The important works relating to the fundamental principles and practices of converting petroleum products into gasoline and other fuels are surveyed and discussed critically. The theories and processes of thermal and catalytic cracking, hydrogenation, polymerization, and alkylation are considered in detail. In this revised edition, catalytic cracking, and the conversion of petroleum gases into modern fuels are presented in special chapters, and other chapters, particularly on reactions of hydrocarbons and synthetic gasolines, were revised and supplemented by new material.

Diamond Tool Patents for Machining Metals and Nonmetallic Substances, Part I, 16 pp., apply. Diamond Tool Patents II, Diamond Abrasive Wheels, 52 pp., 10s. Edited by P. Grodzinski. Industrial Diamond Information Bureau, Industrial Distributors (Sales) Ltd., 32-34 Holborn Viaduct, London, E.C.1, 1945-1948. Paper, $7\frac{1}{4} \times 9\frac{3}{4}$ in., diagrams, tables. These two compilations list and abstract some 100 and 400 patents respectively. The abstracts run from 50 to 100 words each with data on particular compositions usually quoted in full. The purpose of the second list on abrasive wheels is to survey methods of bonding diamond grains, although an appendix also lists patents dealing with the production and use of loose diamond abrasive.

Drilling and Surfacing Practice. By F. H. Colvin and F. A. Stanley. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Can., and London, England, 1948. Cloth $6 \times 9\frac{1}{4}$ in., 523 pp., illus., diagrams, charts, tables, \$5. Written in a simple manner, this book presents the best practices followed in the modern machine shop. In this revised edition are new data on drills of various sizes—new tables on step-drilling, dealing with the use of deep taper pins—new designs and uses for reamers and taps. Improvements in the field of milling machines are discussed, covering the newer types of carbide and high-speed cutters. Methods for increased speed in planning are also demonstrated.

Engineering Machine Shop Practice. By B. R. Hilton. Second edition. Sir Isaac Pitman & Sons, Ltd., London, England, 1946. Fabrikoid, $5 \times 7\frac{1}{2}$ in., 189 pp., illus., diagrams, charts, tables, 6s. This book, written for students and apprentices of production engineering, covers fundamental principles and forms a useful aid to practical work as well as a guide to the technology of the subject. One section gives the more common materials used in engineering together with their characteristics. Suggestions are included on technique, on the correct choice and use of hand and machine tools, and on pitfalls to avoid.

Engineering Thermodynamics. By J. S. Doolittle and A. H. Zerban. International Textbook Co., Scranton, Pa., 1948. Cloth, $6 \times 9\frac{1}{4}$ in., 429 pp., illus., diagrams, charts, tables, \$5. Intended as a text for a year's course in thermodynamics, this book stresses fundamentals of the science, with brief applications to the art of heat-power engineering. The basis of this work is to present as few equations as posssble and then to show how problems may be analyzed and solved by the application of a few fundamental principles. Care is exercised to present but one idea at a time in logical sequence. A brief chapter on gas turbines is included along with the commoner types of heat engines.

Glossary of Wood. By T. Corkhill, published by the Proprietors of *Wood*, the Nema Press Ltd., London, S.W.1, 1948. Cloth, $5 \times 7\frac{1}{2}$ in., 655 pp., diagrams, £1, 1s. A concise library of timber information, this volume is valuable to all concerned in the production, marketing, and fabrication of timber. It explains some 10,000 terms, of which about 1000 are illustrated. Included are descriptions giving classification, qualities, weights, and uses of timbers in commercial use together with terms covering all the woodworking trades, forestry, lumbering, and marketing.

How to Solve Problems in Steam Power Engineering. By S. J. Tracy, Jr. Thomas Y. Crowell Company, New York, N. Y., 1948. Paper, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 152 pp., diagrams, charts, tables, \$1.25. This book provides a comprehensive collection of problems embracing the application of all the basic principles of steam-power theory. Step-by-step solutions for each phase of the subject are given rather than mere variations of a limited set of data. In each chapter the problems have been arranged to provide a logical sequence in analysis and development of major topics.

Jet Propulsion in Commercial Air Transportation. By R. E. Hage. Princeton University Press, Princeton, N. J., 1948. Paper $6\frac{1}{4} \times 9$ in., 91 pp., diagrams, charts, maps, tables, \$1.50. In dealing with this outstanding question, the author discusses the evolution of speed and its effect on commercial transportation, basic power-plant and aerodynamic characteristics, and the case for the turbojet commercial transport.

Latest Developments of Dams and Hydro-Electric Power Stations in France. By A. Coyne. Société des Ingénieurs Civils de France, British Section, London, S.W.1, England, 1947. Paper, $7\frac{1}{2} \times 9\frac{1}{2}$ in., 27 pp., illus., diagrams, 5s. In this pamphlet modern developments in large power-station dams are exemplified in considerable detail by certain French installations with particular reference to flood overfalls of the "ski-jump" type. The technical discussion of the paper is included.

Managerial Control of Business. Edited by G. T. Trundle, Jr., and others. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1948. Linen, $5\frac{3}{4} \times 9\frac{1}{4}$ in., 408 pp., diagrams, charts, tables, \$5. Containing material on every phase of business management, this book stresses the principles and methods actually applied to business and industry today. It includes first an over-all picture and analysis of company operations as they are practiced by leading corporations. Then, after a review of general management problems, the later sections are devoted to discussions of the particular aspects of sales management, manufacturing, and industrial relations. Graphs and tables as well as sample forms used on the job are included.

National Research Council, Highway Research Board, Proceedings of the Twenty-Seventh Annual Meeting, held at Washington, D. C., Dec. 2-5, 1947. Edited by R. W. Crum and others. National Research Council, Washington, D. C., 1948. Cloth, $6\frac{1}{2} \times 9\frac{3}{4}$ in., 523 pp., illus., diagrams, charts, tables, \$7.50. Some forty-five papers and reports are contained in the present volume of this annual publication. They are grouped under six broad headings: economics; finance and administration; design; materials and construction; maintenance; traffic and operations; soils investigations. Information on the work of the committees and on certain awards is also given.

Principles of Metallography. By R. S. Williams and V. O. Homerberg. Fifth edition. McGraw-Hill Book Company, Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, $6 \times 9\frac{1}{4}$ in., 319 pp., illus., diagrams., charts, tables, \$4. This standard text for students of general science and engineering puts greater emphasis on the applications of metallography than on the physicochemical principles involved. In the new edition the major changes have been in revisions and additions to the sections on copper, magnesium, and aluminum alloys, on the hardening and tempering of steel, and on the general question of "hardenability."

Production Control. By L. L. Bethel, W. L. Tann, F. S. Atwater, and E. E. Rung. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, $6 \times 9\frac{1}{4}$ in., 289 pp., illus., diagrams, charts, tables, \$3.50. Originally developed for use by war-production workers, this book has been rewritten in terms of current practice to meet the needs of a collegiate program in management engineering. The general method of presentation is: statement of the basic principles; illustration of the principles through application to specific industrial situations; and case problems to which the student applies the principles involved. Elementary phases of industrial organization and management are omitted. A bibliography is included.

Recommended Practices for Sand Casting Aluminum and Magnesium Alloys. Compiled and published by American Foundrymen's Association, Chicago, Ill., 1948. Paper, 6×9 in., 55 pp., illus., tables, apply. General recommendations are given for molding, melting and pouring, cleaning and finishing, heat-treatment, welding, and the prevention of special defects. The pamphlet also includes the development, chemical control limits, physical properties, conforming specifications, and use of certain specified alloys.

SPHERICAL HARMONICS. By T. M. MacRobert. Second edition, revised. Dover Publications, New York, N. Y., 1947. Cloth, 5 1/2 × 8 3/4 in., 372 pp., diagrams, $4.50. An elementary treatise on harmonic functions for students with a knowledge of calculus but unfamiliar with the method of contour integration or the modern theory of functions of a real variable. On this same basis the book treats Fourier series, Bessel functions, the hypergeometric function and associated Legendre functions. Considerable space has been devoted to applications in mathematical physics and engineering, in particular to problems of mechanical vibrations, heat conduction, potential theory, and electrostatics.

TRENDS IN ENGINEERING EDUCATION, the Columbia Experience. By J. K. Finch. Columbia University Press, New York, N. Y., 1948. Cloth, 5 1/2 × 8 in., 140 pp., charts, tables, $2. Although presenting the philosophy of education of one particular school, the Columbia School of Engineering, this small volume should be of interest to all engineering educators. Two of the most important problems discussed are the broadening of engineering curricula to include basic subjects of general education and the advancement of graduate instruction and research in engineering science. Teaching methods and the problem of faculty appointments have not been considered.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is submitted to the Board on Codes and Standards, as authorized by the Council of The American Society of Mechanical Engineers, for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of October 29, 1948, and approved by the Board on Codes and Standards under the date of Jan. 5, 1949.

CASE No. 994 (*Reopened*)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the requirements of Pars. U-69 and U-70 meet the intent of the Code if the base material is aluminum-manganese alloy conforming to Specification SB-126?

Reply: It is the opinion of the Committee that aluminum-manganese alloy plate and sheets conforming to Specification SB-126 may be used for the construction of unfired pressure vessels under the general requirements of Pars. U-69 and U-70. For vessels constructed under either of these paragraphs, the welding requirements of Par. U-69 and Section IX shall apply except that:

(1) The elongation as determined by the free-bend test shall be not less than 25 per cent;

(2) The rules of Par. U-20 shall be applied using the values in Table U-3 for annealed material for the allowable working stress multiplied by:

(*a*) For Par. U-69 construction, 80 per cent joint efficiency;

(*b*) For Par. U-70 construction, the ratio of SE values given in Par. U-70(a) divided by 11,000.

(3) Thermal stress-relieving is not required and is considered undesirable.

(4) The tensile strength of a reduced-section tension specimen shall be not less than 85 per cent of the minimum specified tensile strength of quarter-hard or as-rolled plate and not less than 95 per cent of the minimum specified tensile strength of annealed plate.

CASE No. 1082 (*Interpretation of Par. P-115(a)*)

Inquiry: May inwardly flanged tube sheets be attached to shells in fire-tube boilers by fillet welding?

Reply: It is the opinion of the Committee that fire-tube boilers may be constructed by inserting an inwardly flanged tube sheet in the shell, attaching it thereto by fillet welding, provided that:

(1) The tube sheet is supported by tubes or braces, or both.

(2) The tube sheet is full fillet welded inside and outside.

(3) The shell at the welds is not in contact with primary furnace gases.

(4) The throats of the full fillet welds are equal to 0.7 of the thickness of the head.

(5) The constructions conforms in all other respects to Code requirements including welding, stress-relieving, etc., except that radiographing is not required.

(6) This construction shall not be used on the rear head of a horizontal-return tubular boiler.

CASE No. 1083 (*Special Ruling*)

Inquiry: Pending revisions of existing ASTM-ASME materials specifications, may nickel-chromium-iron alloys of the compositions listed in Table 1 be substituted and treated as minor deviations of specification requirements, for the composition now required for nickel-chromium-iron alloy?

The acceptance of the above higher chromium compositions is to be predicated on the following understanding:

(*a*) The higher chromium compositions will have resistance to corrosion and oxidation equal to or superior to those of the 12–15 per cent Cr alloy.

(*b*) The mechanical properties of the higher chromium alloys will be equal to those of the 12–15 per cent Cr alloy.

(*c*) The higher chromium compositions are, in other respects, to conform to existing ASTM specifications requirements with respect to tolerances and other test requirements.

Reply: It is the opinion of the Committee that pending revisions of present material specifications, the proposed modification in chemical composition shall be acceptable.

TABLE 1

	Present ASTM-ASME compositions for SB-163, SB-166, SB-167, SB-168 and SA-265 (Ni-Cr-Fe Clad)	Compositions acceptable as minor deviations from ASME Spec.		
		(*a*)	(*b*)	(*c*)
Ni,* % min	75.0	74.0	72.0	72.0
Cr, %	12.0–15.0	13.0–16.0	14.0–17.0	16.0–18.0
Fe, %	9.0 max	9.5	6–10	10.0 max
Cu, % max	0.5	0.5	0.5	0.5
Mn, % max	1.0	1.0	1.0	1.0
C, % max	0.15	0.15	0.15	0.15
Si, % max	0.5	0.5	0.5	0.5
S, % max	0.02	0.02	0.02	0.02

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* Includes small amounts of cobalt.

THE ENGINEERING PROFESSION

News and Notes

AS COMPILED AND EDITED BY A. F. BOCHENEK

Engineering Registration

IN his 25th annual report as executive secretary of the National Council of State Boards of Engineering Examiners, T. Keith Legaré reviewed the growing acceptance by engineers of engineering registration as one of the determinants of professional status.

When the NCSBEE held its first meeting in 1922, registration laws were in existence in only a few scattered states, but now, he said, "the entire country has been covered by statutory requirements for the practice of engineering, except the District of Columbia, where a comprehensive bill now pending in Congress will probably be enacted in the near future."

"There were only about 12,000 registered engineers in 1928, whereas today there are approximately 125,000 and the number is increasing monthly.

Support From Engineering Societies

"Some national engineering societies formerly were either actively opposed to registration or indifferent toward its progress. Most of the principal societies are now supporting the work of the National Council and it was demonstrated at the annual meeting last year that all engineering societies are greatly interested in registration.

"Several years ago many of the engineering educators were definitely opposed to the registration program, but now most of the outstanding educators are co-operating in this important work and are especially interested in the engineer-in-training program.

"The personal attitude of many engineers regarding registration has greatly changed in recent years and we no longer have to read articles or listen to addresses by those who never did really understand the true purpose and value of registration.

"A few years ago young engineering graduates were ignorant of the requirements and procedure of registration and no effort was made to prepare them for this important step in their career, but we now have enthusiastic support of the engineer-in-training program and pamphlets giving information for engineering students.

"For a number of years the progress of the National Council was greatly handicapped by misunderstandings, disagreements, arbitrary attitudes, and lack of intelligent foresight regarding the development of this organization. The functions of the National Council now seem to have the wholehearted support of most of the member boards, engineering societies, engineering colleges, and others concerned.

"The friendly co-operation that has recently developed in connection with all our work has added greatly to the effectiveness of our efforts. We will always be most grateful to those leaders in the National Council and of the engineering societies who have by their loyalty and understanding given encouragement and inspiration both now and in the past."

In its 1948 annual report to Council, the Engineers Registration Committee of The American Society of Mechanical Engineers recommended that "all members of the ASME who can qualify for registration do so. Registration is professional distinction, and when all qualified engineers seek registration, and when all Examining Boards meet Model Law requirements, there will remain little question about engineering being a profession."

Principle Well Established

William N. Carey, secretary, American Society of Civil Engineers, speaking before the conference of officers of western European and American engineering societies held recently in London, England, stated that the principle of registration was thoroughly established in the United States and that it was "extremely unlikely that it will be abolished."

Referring to the requirements for membership in the Founder Societies, he added, "When the state laws shall achieve more reasonable uniformity in their minimum requirements and become more universal in application there is a likelihood that registration may become one of the requirements for membership. . . . "

That registration of engineers was an accomplished fact is also the conclusion of A. M. Sargent, president, Pioneer Engineering and Manufacturing Company, Detroit, Mich., whose booklet, "Professional Registration Laws and the Engineer,"[1] examines the impact of registration on the engineering profession. Although deprecating the "confusion, lack of uniformity, and vagueness of present statutes" he finds that the "intent" of the laws are "sound and valid" and should be enforced as long as they are confined to protecting the public in situations where the public was not free to exercise its own self-interest and judgment.

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[1] Published by A. M. Sargent, 19669 John R Street, Detroit 3, Mich., 60 pp., 75 cents.

Industry and Engineering Education

AMERICAN industry foresees a steadily increasing demand for engineering specialists and expects the colleges to continue to supply engineers of increasingly broader competence. It is willing, for the most part, to help meet the increased costs which such a program of education puts upon the colleges of engineering.

These are the salient views expressed by 550 representative industrialists in an analysis made public by Livingston W. Houston, Mem. ASME, president, Rensselaer Polytechnic Institute, Troy, N. Y.

Before going to the public for funds required by expansion plans, R.P.I. asked more than 1000 top-level industrial executives six questions bearing on the basic problem: How shall engineering colleges meet tomorrow's need for more and better-trained specialists? The fact that 40 per cent of questionnaires were answered was, according to President Houston, "gratifying evidence that industry and business, in general, are keenly aware of the pressing problems facing the colleges of engineering."

What R.P.I. wanted to know was: (1) Whether in the opinion of industry the demand for engineering specialists would increase during the next decade; (2) whether the demand of engineers in management is growing; (3) to what extent are engineers currently employed in management; (4) whether colleges should be expected to compete with industry for top-flight personnel; (5) whether college laboratories should be designed to teach modern production methods, basic principles, or both; and (6) in face of mounting costs, should colleges seek additional funds from increased tuition and governmental subsidies, or should industry and business underwrite part of the cost by giving grants?

Demand for Specialists

Of the 546 executives who replied to the first of the six questions, 419 said the demand for research scientists and engineering specialists in their particular types of industry would be greater during the next 10 years. Demand would be about the same as at present it was thought by 125, while only two believed the demand would be smaller.

K. C. Gardner, Mem. ASME, president, United Engineering and Foundry Company, Pittsburgh, Pa., reported, "We not only need men for use in our engineering and research departments but we need well-trained technical engineers for service abroad."

Engineers as Executives

There were 544 replies to the question as to whether there was a growing demand for executives and managers with engineering backgrounds. Of these 492 said "yes" and 52 said "no."

There were many positive assertions that the growing complexity of industry and business was making it increasingly necessary that executives and managers have sound engineering background. Such a background was deemed particularly important in positions involving control of design, manufacture, and the analysis of trends.

Typical of numerous clear expressions of opinion on this subject was that of W. R. Herod, president, International General Electric Company, New York, N. Y., who wrote: "A background in the engineering and technological fields is desirable, but it is essential that these executives have a broader view than merely the technical field. They must have a knowledge of human relationships, history, economics."

In answering question three, 525 respondents estimated, on the average, that 38 per cent of the executive and managerial positions in their companies were presently held by graduates of colleges of engineering.

This average, it was pointed out in the analysis, would have been materially higher had not there been the effort to obtain opinion from all types of industry. As a result of this effort, some 40 of the replies came from service, food, or specialty interests which often employ few engineers or research scientists.

Faculty-Salary Standards

The fourth question asked whether the colleges of engineering, in obtaining top-flight personnel, should be expected to compete with industry by offering salaries more nearly comparable to those paid by industry.

Of the 512 industry executives who replied, 400 said that salaries should be more nearly comparable, while 112 said "no."

Numerous commentators, both "yes" and "no," said the best teachers were those with practical experience in industry. Some of those answering "yes" pointed out that a man with the background of practical experience was just the one who was not likely to sacrifice income for the life of a teacher, even with its "psychic" advantages.

Thorough Laboratory Training

Asked, in question five, whether college laboratories should be designed primarily to teach modern production methods, basic principles, or both, 529 answered. Only six said modern production methods alone, while 221 said "basic principles" and 302 said "both."

Most of those holding that basic principles only should be taught expressed the opinion that the college laboratory had neither the time nor the equipment for a tremendously complex job and that it was a natural function of industry to train workers in modern production methods. Even stronger, however, was their belief that a thorough grounding in basic principles was the vital preparation for a competent engineer and that, given a thorough grounding, he could readily absorb modern production ideas and methods.

Aid for Colleges

In reply to the question of where colleges were to find additional financial support to meet mounting costs, 205 of the executives who answered the question said, "Increase tuition and obtain the support of business and industry." There were 111 who saw no other solution than an increase in tuition, while 26 others said the answer lay in increased tuition plus government subsidy. Comment on this question was highly varied, but approximately one fourth mentioned "governmental subsidies."

About one half of the respondents favored industry and business underwriting cost of college training of the engineers and specialists they required.

Economic Stability

SINCE national economic stability is as vital to the engineering profession as it is to business and labor, recent recommendations on the problem by the Committee for Economic Development warrant careful consideration by engineers.

The recommendations are part of the first CED study in its series "Monetary and Fiscal Policy for Greater Economic Stability." The report undertakes to answer the question: Can a free society in these crisis times steer a middle course of stability between the dangers of economic collapse and extreme inflation, meanwhile strengthening its national defense, and yet preserve for its members basic economic and political freedom?

While pointing out that monetary and fiscal policy cannot of itself offer the solution to instability in a free economy, CED believes that the program it recommends can make a major contribution to greater stability.

Periods of Inflation

In periods of inflation, the CED recommends: (1) Hold tax rates stable, so that tax revenues will rise as the national income rises and the government surplus will increase; (2) use the government surplus to retire debt held by the commercial banking system, including the Federal Reserve banks; (3) refund maturing government debt in a way that will reduce the holdings of the banking system; (4) tighten the reserve position of the banks, by Federal Reserve sale of government securities in the open market, by increase of rediscount rates, and by increase of reserve requirements; and (5) reduce the volume of government loans and guarantee of loans.

Periods of Depression

In periods of depression, the report recommends: (1) Hold tax rates stable, so that tax revenues will fall as the national income falls and the government surplus will decline or turn into a deficit. In extreme conditions a temporary reduction in tax rates may be desirable to stimulate private expenditure; (2) expand the money supply and increase bank reserves by open-market purchase of government securities; further ease the reserve position of the banks by reduction of rediscount rates and by reduction of reserve requirements; (3) finance the deficit, if there is one, by borrowing in a way that will induce the commercial banking system to acquire government securities, with such Federal Reserve action in providing additional bank reserves as may be necessary for this purpose; (4) refinance maturing Federal debt in part by borrowing from the commercial banking system, including the Federal Reserve banks; (5) expand the volume of Federal loans and guarantees of loans, within the scope of the Federal loan program accepted as appropriate in the long run.

The statement calls the Federal Reserve System's support of long-term government bonds "the currently most important problem" of Federal monetary policy. Purchase of government securities by the Federal Reserve in support of the long-term government bond market adds to bank reserves and, unless offset, permits an expansion of bank credit and the money supply, CED points out.

Other Studies Due

Other studies in the series will be released as soon as the research work is completed. They include: "Federal Tax Policy for 1949;" "How to Raise Real Wages;" "World Economic Readjustment;" "Controls Vs. Prices for Allocating Resources in a Defense Economy;" and "How to Preserve Our Freedom While Rearming."

The chairman of the Committee for Economic Development's board of trustees is W. Walter Williams, president of Continental, Inc., Seattle, Wash. The chairman of the CED Research and Policy Committee is Philip D. Reed, chairman of the board of the General Electric Company.

ECPD Accrediting Program

DURING 1948 the Committee on Engineering Schools of the Engineers' Council for Professional Development added 33 curriculums offered by 16 engineering schools granting degrees to the list of accredited undergraduate engineering curriculums accredited since 1932. The new schools are listed in the preprint from the 16th annual report of the ECPD which may be obtained for 25 cents from the Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y.

1948 Additions to Accredited List

Newly accredited curriculums are: Metallurgical, University of Cincinnati; aeronautical, University of Colorado; mechanical, University of Denver; electrical, mechanical, metallurgical, and structural, Fenn College; aeronautical and civil including public-health option, University of Florida; civil and electrical (re-accredited), Howard University; chemical, Montana State College; chemical, industrial, and mechanical, including aeronautical option, North Carolina State College; civil and electrical, North Dakota Agricultural College; mechanical, University of South Carolina; civil, including municipal and sanitary option, Texas A&M College; aeronautical and ceramic, University of Texas; aeronautical, architectural, civil, including sanitary major, metallurgical, and mining, Virginia Poly. Inst.; chemical, civil, including construction option, and geological, Washington University; chemical, West Virginia University.

Since the program began the ECPD has accredited one or more curriculums in 142 of the more than 160 engineering degree-granting institutions in the United States. Curriculums in six institutions have been inspected but not accredited, while 25 schools have not yet invited ECPD to evaluate their curriculums.

The accrediting program, one of the major ECPD activities, seeks "to formulate criteria for colleges of engineering which will insure to their graduates a sound educational background for practicing the engineering profession."

As a basic policy the ECPD does not attempt to rate engineering schools but evaluates individual curriculums offered by the schools. Curriculums are studied only upon invitation. Rigid standards for accrediting are avoided to prevent standardization of engineering education. A curriculum is denied accrediting only when it omits significant portions of the subject in which the public expects engineers to have competence.

Accrediting Procedure

The accrediting procedure commences when the ECPD Committee on Engineering Schools receives an invitation to evaluate specific curriculums of an institution. The Committee's first step is to assign a regional subcommittee the task of securing by questionnaire all information needed about the curriculums, and later of inspecting the educational facilities of the institution. The inspection committee reports its observations to ECPD regional committee which, after considering all available information, submits its recommendations to the Committee on Engineering Schools. Final decision as to accrediting rests with the ECPD.

Because of the urgency of the undergraduate program the ECPD has deferred accrediting of graduate curriculums. This program is in the future and will be instituted as soon as possible.

The ECPD also accredits curriculums of the technical institutes whose programs prepare students for industrial employment at levels intermediate between those served by the engineering colleges and the vocational schools. Although this activity was curtailed by the war, the ECPD 16th Annual Report lists 24 curriculums in 12 technical institutes which have been accredited.

AIME Introduces New Publication Plan

WITH the release of the first issue of *Mining Engineering* in January, 1949, the American Institute of Mining and Metallurgical Engineers puts into effect its new publication plan tailored to provide a specialized publications service to each of the three main branches composing its membership: mining engineers, metallurgists, and geologists.

The new plan discontinues the four Technologies and *Mining and Metallurgy*, which has been the official publication of the AIME for 29 years, and institutes three new journals of which *Mining Engineering* is one. The others are *Journal of Metals* and *Journal of Petroleum Technology*.

Mining Engineering is being published for the mining-branch members who are interested in ore finding, mining, and concentrating methods and equipment related to metallic and nonmetallic ores and coal. Each issue will contain operating articles and technical papers. Utilization and economics will also be covered.

Journal of Metals will be published for the metallurgical branch of the Institute and will include papers formerly published in Metals Technology. The *Journal of Petroleum Technology* will be published for petroleum engineers and geologists and will include papers formerly published in Petroleum Technology.

Each of the journals will have three sections one of which will be a common section containing material of general professional interest, and news of the activities of the Institute and its members. One section will carry specialized papers of interest to members to whom the journal is addressed. The third section will carry shorter and less formal articles, and news of the industries covered by the individual publication.

Payment of dues will entitle Institute members to receive any one of the journals. For each additional journal, members will be asked to pay $4.

Massachusetts Adopts ASME Boiler Code

THE Commonwealth of Massachusetts recently became the 30th state to adopt the Power Boiler Code of The American Society of Mechanical Engineers as the basic rules for boiler construction and inspection. The action was taken by the Massachusetts Board on Boiler Rules at a public hearing held in Boston, Mass., Dec. 3, 1948. The Board canceled the Massachusetts boiler rules as published in Form "U" and adopted Sections I, II, and IX of the 1946 Power Boiler Code with 1947 and 1948 addenda. Section I covers construction of power boilers, Section II materials specifications, and Section IX welding qualifications.

The action was particularly gratifying to the ASME because of the historical association of the ASME Boiler Code Committee and the Massachusetts Board. Massachusetts boiler safety legislation actually antedates the ASME Boiler Code by a few years. Success of the pioneer effort by Massachusetts in legislating boiler safety encouraged the ASME in 1911 to draft its own boiler safety code to serve as a model for other states seeking to establish boiler safety rules. The ASME code was modeled along the lines laid down by Massachusetts engineers and through the years there has continued a liaison between the Board and the ASME Boiler Code Committee.

Last May when this relationship was commemorated by a special meeting in Boston, Mass., sponsored by the ASME Boston Section and attended by members of the Massachusetts Board, the National Board of Boiler and Pressure Vessel Inspectors, and the ASME Boiler Code Committee, adoption by Massachusetts of the ASME Code was discussed briefly.

Six months later Massachusetts adopted the Code.

Meetings of Other Societies

March 6–10
American Institute of Chemical Engineers, Los Angeles (regional) meeting, Biltmore Hotel, Los Angeles, Calif.

March 8–10
Society of Automotive Engineers, Inc., passenger car body and production meeting, Hotel Book-Cadillac, Detroit, Mich.

March 10–12
American Society of Tool Engineers, annual meeting, Hotel William Penn, Pittsburgh, Pa.

March 27–April 1
American Chemical Society, 115th national meeting, San Francisco, Calif.

March 28–30
Society of Automotive Engineers, Inc., transportation meeting, The Statler Hotel, Cleveland, Ohio.

March 14–17
1949 Chicago Technical Conference and Production Show, Hotel Stevens, Chicago, Ill.

April 11–13
American Society of Lubrication Engineers, 4th annual convention and 2nd all-lubrication exhibit, Hotel Statler, New York, N. Y.

April 11–14
The National Association of Corrosion Engineers, annual conference and exhibition, Netherland-Plaza Hotel, Cincinnati, Ohio.

April 11–15
American Society for Metals, western metal congress, Hotel Biltmore, Los Angeles, Calif.

April 20–23
American Society of Civil Engineers, spring meeting, Hotel Biltmore, Oklahoma City, Okla.

April 26
National Academy of Sciences, annual meeting, Washington, D. C.

(For ASME Coming Events see page 189)

Two Jet Propulsion Centers Established

ESTABLISHMENT of two national centers of rocket and jet propulsion study and research, to be located at Princeton University in the east and California Institute of Technology in the west, was announced jointly by Harry F. Guggenheim, president of The Daniel and Florence Guggenheim Foundation, Harold W. Dodds, president of Princeton University, Princeton, N. J., and Lee A. DuBridge, president of California Institute of Technology, Pasadena, Calif.

Hailed as a major stimulant to the development of rockets and jet propulsion and one of the most striking postwar developments in engineering education, the new institutions will be known as Daniel and Florence Guggenheim Jet Propulsion Centers. Each will provide facilities for postgraduate education and research in jet-propulsion and rocket engineering. They will emphasize particularly the development of peacetime uses of rockets and jet propulsion.

The Daniel and Florence Guggenheim Foundation has underwritten the two Jet Propulsion Centers for a period of seven years, and has appropriated $500,000 for that purpose. These funds are to be used to pay salaries of professors, stipends of graduate students, and similar expenses. Necessary buildings and equipment are to be provided by the universities.

Honor Dr. Goddard

Mr. Guggenheim, in announcing the new Centers, explained that the principal post in each will be a Robert H. Goddard Professorship, named in honor of the American rocket pioneer, Dr. Robert H. Goddard. Each Goddard Professorship will be associated with a number of postgraduate fellowships. Normally six new fellowships will be granted each year by the Foundation—three for study at each Center.

The Foundation fellowships will be known as Daniel and Florence Guggenheim Jet Propulsion Fellowships. They will carry a stipend of up to $2000 per year each, and will be granted for two-year study toward advanced degrees. They will be awarded to unusually promising graduate students in jet propulsion, following an annual nation-wide search for the best available candidates.

Threefold Purpose

The object of the Centers is threefold, Mr. Guggenheim said:

"They will serve as training centers for leaders of the future in the field of rocket technology. They will be centers of research and advanced thinking on rocket and jet-propulsion problems. And they will be centers of leadership in the development of peacetime commercial and scientific uses of rockets and jet propulsion."

Selection of Princeton and California Institute of Technology for location of the new Centers followed a nation-wide study of various universities in which rocket and jet-propulsion work is now going on, Mr. Guggenheim explained.

Higher Professional Outlook for Engineers Urged at ASEE Winter Meeting

DEANS and professors from 21 eastern engineering schools were told recently that a higher professional outlook, greater consciousness of civic responsibilities, and an increase in domestic discipline were necessary if engineers were to fulfill successfully the obligations placed upon them by modern technology.

Speaking before the winter meeting of the Middle Atlantic Section of the American Society for Engineering Education held at the Drexel Institute of Technology, Philadelphia, Pa., Dec. 11, 1948, William F. Ryan, Fellow ASME, Stone and Webster Engineering Corporation, Boston, Mass., said, "Since service to humanity is the prime objective of a profession, a higher professional outlook among our engineering graduates is a matter of national importance." He praised the work being done by the engineering schools from a technical point of view, but charged that ". . . our engineering schools are preparing men not only to make more and better things, but to fulfill their obligations to society as members of a profession."

Mr. Ryan called attention to the achievement of scientists in providing scientific know-how in the development of atomic energy. Before this knowledge could be translated to actual plants it was necessary for engineers to contribute their skill. He said that engineers have not assumed or received sufficient credit for the important part they played.

Getting Along With Russia

James Creese, president of Drexel, in his greetings to the engineers, pointed out the advisability of attempting to get along with Russia through the services, concepts, and language of engineers.

"The border is tightly closed against all kinds of communications with the Russian people," said Dr. Creese. "Unless some opening is found, it will continue to be impossible to identify these common interests of the two peoples on which formal negotiations would have to rest. Are there any openings untried? Perhaps there are.

"Our scientists and technologists seem to get on reasonably well together when they have a chance to meet. They have common professional interests. Possibly those who have the most thorough professional knowledge of the instruments and the methods of industrial production would be more genuinely welcomed in Russia than our ablest and most enlightened statesmen, politicians, military commanders, or men of law. All these others are suspect from the Russian point of view."

Teaching Techniques

Of particular interest to mechanical-engineering teachers was the afternoon session at which Prof. J. H. Billings, Mem. ASME, Drexel Institute, was chairman. This session was devoted to the topic, "What Are the Techniques of Effective Teaching in Engineering?" Three speakers covered this subject. Dean David L. Arm, Mem. ASME, of the University of Delaware, discussed the requirements for teachers. These requirements he broke down into two categories: the first was concerned with technical competence, broad education in the technical field, experience, and active participation in professional societies; the second requirement was concerned with personal characteristics.

Prof. Milton C. Stuart, Mem. ASME, Lehigh University, reviewed the students' requirements of teachers as covered by various types of student-rating methods. He reviewed some of the results of some of the methods, pointing out their advantages and disadvantages. Prof. Albert H. Repscha, Mem. ASME, Drexel Institute, reviewed some of the requirements for effective teaching in laboratory courses.

ASME MEMBERS WHO TOOK PART IN THE MECHANICAL-ENGINEERING PANEL AT THE ASEE MIDDLE ATLANTIC SECTION MEETING IN PHILADELPHIA, PA.

(*Left to right:* Milton C. Stuart, Lehigh University; J. H. Billings, Drexel Institute; David L. Arm, University of Delaware; and Albert H. Repscha, Drexel Institute.)

AIEE Conference to Discuss Industrial Application of Electron Tubes

A CONFERENCE on the industrial application of electron tubes, sponsored by the American Institute of Electrical Engineers, will be held in the Statler Hotel, Buffalo, N. Y., April 11–12, 1949. The conference will provide means for electron-tube users to discuss mutual problems with control-equipment designers and tube manufacturers.

The program for the first day will include a technical session on the application of electron tubes in control and other industrial equipment, an inspection trip to the new Westinghouse plant in Buffalo, and a presentation of several papers by the users of electron tubes describing their operating experience and maintenance.

The second day will be devoted to a discussion of the items which the equipment manufacturers consider in designing control and other equipment using tubes, followed by a technical session on the methods used by the electron-tube manufacturers in building and rating tubes for industrial applications.

Agenda Announced for First Pan-American Engineering Congress

TO PROVIDE engineers of the Western Hemisphere with the equivalent of a "town meeting" at which to strengthen "good neighbor" relations and to discuss the common engineering problems of the Americas, the South American Union of Engineering Associations (USAI) is sponsoring the First Pan-American Engineering Congress, to be held in Rio de Janeiro, Brazil, July 15–24, 1949. Engineering associations in other American countries are co-operating in the Congress. American participation is being organized by the Engineers Joint Council. The theme of the Congress is "Engineering in the Service of Peace."

The agenda has been planned around eight topics of major interest to engineers of the Americas. These are: Transportation and communication; construction; power; urban and rural engineering; sanitary engineering; industrial engineering; mining engineering and geology; teaching of engineering.

Transportation topics include: Pan-American railway; standardization of railway equipment; uniformity of railway statistics; barter agreements for raw materials and steel products of interest to the railway industry; Pan-American highways; international traffic regulations for various classes of vehicles; basis of chartering of ships; and port facilities.

Construction topics will include foundations, structures, building methods, and technical services.

Power Topics

The power section will hear brief résumés of hydroelectric-power utilization in each country; studies of American fuel resources and best use to supply continental requirements; and reports on latest developments in industrial and domestic utilization of electric power. The control and peacetime application of nuclear energy are also on the agenda.

Under urban and rural engineering the agenda lists city planning; standardization of materials; public-utility services; and traffic regulations.

The sanitary-engineering section will hear reports of conditions and progress of sanitary-engineering work in each country, including management and design of urban water systems; flood control; pollution and self-purification of streams; and sewage disposal.

The agenda for the mining-engineering section lists twelve topics which include reports of mineral reserves and annual production figures; mining methods; mining legislation; and résumés of development and the significance of mining in national and hemisphere economy.

Engineering Education

The eighth section of the Congress will consider engineering education in the Americas. The subjects to be discussed will include curriculums; selection of students; scholarships; validation of degrees; and interchange of studies on engineering educational problems.

The ninth section will deal with miscellaneous problems. These include engineering standards; census of general requirements and productive capacity of the various countries; studies of the relation of engineering to public administration problems; and the influence of engineering on the general development of American countries.

United States engineers interested in participating in the Congress are urged to write to the Engineers Joint Council, 29 West 39th Street, New York 18, N. Y., for complete agenda and other particulars. Papers to the Congress may be contributed until April 30, 1949.

DEMA Annual Meeting Discusses Coal Gasification

THE increasing use of Diesel engines capable of burning oil and gas fuels was reflected in the presence of engineers representing filter-manufacturing companies, the Bituminous Coal Research, Inc., Battelle Memorial Institute, and the Rural Electrification Administration, at the 1948 annual meeting of the Diesel Engine Manufacturers Association, held in Chicago, Ill., Dec. 8, 1948.

Having developed the dual-fuel engine, the Diesel industry is seeking assurance that gas would be available wherever the engines were in service. It was also interested in the quality and quantity of available gas as well as its cost.

Harold J. Rose, Mem. ASME, vice-president, Bituminous Coal Research, Inc., told the Diesel manufacturers that Battelle Memorial Institute, which conducts the biggest single group of projects for the BCR, would be interested in co-operating on a research program for development of gas producers for dual-fuel engines of 200 hp capacity and over.

Speaking for the Battelle Institute, Ralph A. Sherman, director at large, ASME, stated that his organization had under way an extensive program of gasification of coal, because it believes that this is the most economical way to use the nation's coal resources.

Good Gas-Producing Unit Needed

The need for a good gas-producing unit was emphasized by Carl E. Miller, Mem. ASME, Battelle Memorial Institute, who said that present-day producers are too big—they must be smaller, portable, and less costly. They must produce clean gas and be "reasonably automatic and fool-proof in so far as the operator is concerned." He added that Battelle had $27,000 with which to conduct development work on a gas producer during 1949, but that a project of this nature usually required five years and indicated that a larger fund would be needed.

In the ensuing question-and-answer period, Harlan W. Nelson, supervisor of Battelle's fuels research, said that an economic study of a producer yielding a gas of 150 to 180 Btu per cu ft indicated that the cost of such gas would be approximately 5.6 cents per therm (100,000 Btu) with coal at $7.50 per ton. He added that the Diesel industry was not the only one evincing an interest in availability of gas, for such interest has been expressed by the brick, glass, and steel industries.

Joint Committee Organized

J. B. Morrow, president, BCR, commented that the possibility of economical production of oxygen-enriched air might yield dividends in the economic production of producer gas with heating values as high as 450 Btu.

Definite action resulted from the discussion when it was decided to form a joint committee to work toward an adequate supply of gas for dual-fuel engines. The committee will be drawn from the personnel of the Diesel industry and Battelle Memorial Institute. The committee's objective will be twofold: To study possible developments on the part of companies already making producer equipment; and to study the possibilities of concentrated research of coal companies and various other industries interested in this kind of equipment.

ASME Expands Research Activities

CONTINUING its effectiveness in sponsoring researches of broad industrial interest, The American Society of Mechanical Engineers in 1948 disbursed $27,000 for the support of several projects designed to provide information on such problems as those of stress patterns developed in steel bars in actual rolling operations, the effect of pressure on viscosity of lubricants, factors affecting the performance of high-capacity boiler furnaces, and further studies of fluid-meter elements.

In 1949 ASME plans to spend as much as $50,000 for the continuation of these projects and initiation of new ones. This work is made possible by industrial subscriptions and grants from The Engineering Foundation for specific broad-interest programs. Industry-contributed services, facilities, and personnel ordinarily amount to from two to four times the actual cash expenditures.

Background research sponsored by the Society has made available to the engineering profession many design tools, improved techniques, and engineering data which have aided engineering developments in many industries. Among these are the steam tables; means for avoiding corrosion, scaling, foaming, and caustic embrittlement in steam generation; improved methods of water analysis; solutions to a variety of fundamental lubrication problems; authoritative information on the design, application, and installation of fluid meters for various services, as well as discharge coefficients for orifices and procedures for the use of flow nozzles; metal-cutting data, such as tool design and materials, cooling, lubrication, feeds, and speeds; properties of alloy steels for high-temperature service; and a better understanding of the design and operation of elevator safety devices, buffers, and associated mechanisms, together with test methods for the approval of safety devices.

A growth in the scale of ASME research activity is expected as a result of a current program aimed at developing a greater realization among members and industries of the importance of co-operative attack on specific problems of common interest to one or more industries.

People

BURGESS H. JENNINGS, Mem. ASME, chairman, department of mechanical engineering, Northwestern University, Evanston, Ill., was elected president, of the American Society of Refrigerating Engineers during the 44th annual meeting of the society held recently at the Hotel Statler, Washington, D. C.

* * *

THE 1949 officers of the National Society of Professional Engineers include William F. Ryan, Fellow ASME, engineering manager, Stone and Webster Engineering Corporation, Boston, Mass., and Cherry Logan Emerson, Mem. ASME, vice-president, Georgia Institute of Technology, Atlanta, Ga. Mr. Ryan is serving as vice-president of the NSPE northeastern region and Dean Emerson as vice-president of the NSPE southeastern region.

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C. E. DAVIES, secretary ASME, has been elected a trustee of Rensselaer Polytechnic Institute for a four-year term.

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HENRY L. BROWNBACK, Mem. ASME, was recently named a Chevalier of the Legion of Honor by the president of France. The nomination was made by the Centre Technique de l'Automobile, part of the Ministry of Industrial Production, in recognition of Mr. Brownback's engineering work in France.

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GEORGE E. ZIEGLER was recently appointed director and Clayton O. Dohrenwend, Mem. ASME, assistant director of the Midwest Research Institute, Kansas City, Mo.

Engineering Literature

ESL Translations

A NEW translation of an extensive French paper on the viscosity of gases at high temperatures has been made for the Bibliography and Translations Committee, Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers. A copy of the translation has been deposited in the Engineering Societies Library, 29 W. 39th Street, New York 18, N. Y., where it is available for consultation or a photostatic copy can be supplied. The paper is:

EXPERIMENTAL RESEARCHES ON THE VISCOSITY OF GASES AT HIGH TEMPERATURES, by Virgile Vasilesco, translated from *Annales de Physique*, series 11, vol. 20, 1945, pp. 137–176, 292–334. Engineering Societies Library translation file no. 2439. Cost of a photostatic copy, $24.40.

Two other translations made for the same committee about two years ago are also available. These are:

STANDARDIZED NOZZLES AND ORIFICES USED IN CLOSED CIRCUITS, by Mario Marchetti, translated from *L'Energia Elettrica*, vol. 12, 1935, pp. 789–811. Engineering Societies Library translation file no. 2355. Cost of a photostatic copy, $17.60.

VISCOSITY OF GASES, ITS DETERMINATION, AND ITS SIGNIFICATION IN FLOW MEASUREMENT, by Walter Ruppert, translated from *Die Messtechnik*, vol. 8, 1932, pp. 237–242. Engineering Societies Library translation file no. 2356. Cost of a photostatic copy, $4.

New Standard on Symbols for Physics Published

A NEW publication in the series of standard letter symbols for use in technical and scientific writing has just been announced by The American Society of Mechanical Engineers. This is the "American Standard Letter Symbols for Physics, Z10. 6–1948."

The 37-page standard was developed by the Sectional Committee on Letter Symbols and Abbreviations for Science and Industry organized under the procedures of the American Standards Association and sponsored jointly by The American Society of Civil Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society for Engineering Education, and American Association for the Advancement of Science. In all, 36 national societies, associations, and governmental departments took part in the work which resulted in agreements on the standard symbols.

A subcommittee of the general committee was assigned the task of developing the letter symbols for physics, but because physics covers such a wide field, this subcommittee co-operated with committees developing symbols in other fields in order that the same symbols could be used for the same idea in all fields wherever possible. The standard included all common terms in elementary physics and some in advanced physics, physics and related fields, but most symbols in mathematics, crystallography, meteorology, x rays, and statistics, are omitted.

Price of the standard is $1 and may be obtained from ASME Publications Sales, 29 West 39th Street, New York 18, N. Y.

Cast-Iron Pipe Flanges and Flanged Fittings Standard Published

THE American Society of Mechanical Engineers has just published "American Standard Cast-Iron Pipe Flanges and Flanged Fittings, Class 125, ASA B 16.1–1948," which is a revision of the 1939 edition and the 1943 American War Standard entitled "Pressure Ratings for Cast-Iron Pipe Flanges and Flanged Fittings, 125 lb."

The revision was completed by the Sectional Committee on the Standardization of Pipe Flanges and Fittings sponsored by The American Society of Mechanical Engineers, the Heating, Piping, and Air Conditioning Contractors National Association, and the Manufacturers Standardization Society of the Valve and Fittings Industry, under procedures of the American Standards Association.

In bringing data in line with present practice, the latest edition contains a revision of the section covering introductory notes, reduces Tables 4, 5, and 7 to a common table, adds two new sizes of short-body pattern reducing tees, and eliminates the appendix.

Data included cover pressure ratings, sizes, markings, minimum requirements for materials, dimensions and tolerances, bolt, nut, and gasket dimensions, and tests.

Price of the Standard is 65 cents. Copies may be obtained from ASME Publications Sales, 29 West 39th Street, New York 18, N. Y.

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THE Tin Research Institute of Great Britain has recently released a new edition of its handbook, "Notes on Soldering." The 88-page booklet reviews the vast literature on the subject and presents a compilation of the more important facts of value to solder users. Advances in soldering technique are discussed, and special emphasis is given to design for soldering. The booklet is offered free of charge. Copies may be obtained by writing to Dr. Bruce Gonser, The Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio.

Education

RECENT additions to educational facilities in Canada include new mechanical-engineering buildings at the University of Toronto,

Toronto, Ont., and at Queen's University, Kingston, Ont.

ESTABLISHMENT of a number of Howard Hughes Fellowships in creative aeronautics was announced recently by Lee A. Dubridge, president, California Institute of Technology, Pasadena, Calif.

Each fellowship will consist of a gift of $1500 to the Institute from Howard Hughes, aircraft builder, to cover tuition and research expenses, an additional gift of $1500 or more to each fellow depending on his qualifications, and a salary of at least $2000 for advanced development work at Mr. Hughes's aircraft plant in Culver City, Calif.

Each year two or three awards will be made to candidates whose qualifications will admit them to graduate study leading to the degree of doctor of philosophy in aeronautics or physics.

According to Dr. Dubridge, the fellowships aim "to remedy a shortage in a class of engineers upon which the future of aeronautics depends."

LUIS H. BARTLETT, Mem. ASME, director, Engineering Experimental Station, Louisiana State University, Baton Rouge, La., and E. B. Norris, Mem. ASME, director, Engineering Experimental Station, Virginia Polytechnic Institute, Blacksburg, Va., were among 14 scientists and engineers, named to the advisory board of the new scientific journal, *The Journal of Southeastern Research*.

A NUMBER of graduate study, research, and teaching fellowships, scholarships, and assistantships in special fields of study such as power-system engineering, gas technology, and industrial research are open at the Illinois Institute of Technology, Chicago 16, Ill. Applications will be accepted until March 15, 1949. Applications should be addressed to Examiner of Credentials, Graduate School.

WITH no drop in building costs expected in the near future, Carnegie Institute of Technology has decided to go ahead with its four-million dollar building and renovation program decided upon but held in abeyance since March, 1947. Plans call for a million-dollar power plant, a new wing on Engineering Hall, and extensive renovation of space in other buildings.

TEN fellowships in the fields of business and engineering administration will be awarded to young executives chosen in a national competition in a resumption after a recess during the war, of the Sloan Fellowship Program for Executive Development at the Massachusetts Institute of Technology, Cambridge, Mass. The awards this year are made possible by a new grant of $225,000 from the foundation.

The fellowships, awarded on the basis of merit in a nation-wide competition, will carry stipends up to $4000 for married men and $3000 for single men. Recipients, on leave of absence from their employers, will be in residence at the Institute from June 10, 1949, to June 15, 1950, and will engage as a group in a special program. In selecting the total group of approximately ten fellows, an attempt will be made to have represented a diversity of industries, size of companies, geographic areas, and types of experience.

Details of the competition may be obtained from Prof. Gerald B. Tallman, department of business and engineering administration, who is director of the Sloan program and who will supervise selection of the fellows.

Awards

Malcolm Pirnie Receives 1948 Hoover Medal

THE Hoover Medal for 1948, one of the high awards of the engineering profession, was conferred on Malcolm Pirnie, consulting engineer, New York, N. Y., in recognition of his leadership in the formulation of a program sponsored by the Engineers Joint Council for the postwar industrial control of Germany and Japan.

The medal was presented during the 96th annual meeting of The American Society of Civil Engineers, held at Hotel Commodore, New York, N. Y., Jan. 19, 1949. Mr. Pirnie is a past-president of the ASCE. The citation read:

"Malcolm Pirnie, engineer, leader of engineers and servant of his fellow man, whose ideals and accomplishments in public life beyond the call of his profession have benefited men in his own and other countries of the world, is awarded by his fellow engineers the Hoover Medal for 1948."

The Hoover Medal is of gold, and bears the inscription: "Awarded by Engineers to a Fellow Engineer for Distinguished Public Service." It was instituted in 1930 and was first presented to Herbert Hoover, for whom it was named, "in recognition of his humanitarian principles and public service." Since then it has been conferred nine times. The last previous award was for 1946 and went to Vannevar Bush.

It is jointly awarded by the Founder Societies: American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

The program for the industrial disarmament of the aggressor nations, in which Mr. Pirnie played a leading part, was a voluntary contribution of the engineering profession toward world peace. It was carried on by the Engineers Joint Council through its National Engineers Committee, with Mr. Pirnie as chairman. The Founder Societies and the American Institute of Chemical Engineers are represented on this council.

The program for Germany got under way in 1944. It stated one clear objective—"an effective industrial means to keep Germany from starting another war." Removal of the plant and source materials essential to war was advocated but "with the least disturbance to the normal economy of Western Europe." The program opposed "any plan which would make postwar Germany a drag on the economy of all Europe, if not of the world, and a breeder of future wars."

Later a similar report was prepared on the industrial disarmament of Japan. These reports, with their factual and scientific approach to the world recovery program, were approved in principle and in their main essentials by the State Department and Allied Control Council.

ALLAN P. COLBURN, 1948 chairman of the ASME Heat Transfer Division, assistant to president and adviser on research, University of Delaware, Newark, Del., was recently awarded the first Professional Progress Award in Chemical Engineering at the annual meeting of the American Institute of Chemical Engineers. The award was established by the Celanese Corporation of America and carries a stipend of $1000.

The award is to be conferred annually on a person in the chemical-engineering field who has not yet reached his forty-fifth birthday and will be granted for "a theoretical discovery or development of a new principle in the field of chemical engineering; a development of a new process or product; an invention or development of new equipment; or distinguished service rendered in the field or profession of chemical engineering."

* * *

RALPH H. PHELPS, director, Engineering Societies Library, New York, N. Y., was recently awarded the Army-Navy Certificate of Appreciation in recognition of his contributions to the work of the Office of Scientific Research and Development during World War II. Similarly honored were Morrough P. O'Brien, Mem. ASME, dean, college of engineering, University of California, Berkeley, Calif., and Jerome Strauss, Mem. ASME, vice-president, Vanadium Corporation of America, New York, N. Y. In all, 725 scientists and engineers have been named to receive this joint Army-Navy award.

* * *

WILLIAM F. DURAND, past-president and Hon. Mem. ASME, was awarded the Wright Brothers Memorial Trophy "for significant public service of enduring value to aviation in the United States." The trophy which is a 12-in. model of the Wright brothers' plane, was accepted for Dr. Durand by John F. Victory, executive secretary of the National Advisory Committee for Aeronautics, at an Aero Club dinner, Washington, D. C., one of the events honoring the forty-fifth anniversary of the Wright brothers' first flight at Kitty Hawk, N. C. Dr. Durand is the first recipient of the award.

* * *

EUGENE McAULIFFE, chairman of the board, Union Pacific Coal Company, Omaha, Neb., will be the first recipient of the Erskine Ramsay Medal of the American Institute of Mining and Metallurgical Engineers. The medal was established recently and recognizes distinguished achievement in the production, beneficiation, or utilization of bituminous or anthracite coal. Mr. McAuliffe is to receive the medal at the AIME annual meeting to be held at the Palace Hotel, San Francisco, Calif., Feb. 16, 1949.

ASME NEWS

Connecticut Sections to Be Hosts at ASME 1949 Spring Meeting

May 2–4, 1949

Headquarters: Mohican Hotel, New London, Conn.

THE Connecticut Sections of The American Society of Mechanical Engineers, consisting of the ASME Fairfield County, Hartford, New Haven, New London, and Waterbury Sections, will be hosts to the Society at the ASME 1949 Spring Meeting to be held at the Mohican Hotel, New London, Conn., May 2–4, 1949.

Advance information from the General Committee of the Connecticut sections indicates that a full three-day program, liberally interspersed with many plant trips to near-by industrial plants, is in store for ASME members and guests.

As the home of the American submarine and a colorful old-time whaling and sealing center, New London has much to offer of historical interest.

An idea of the wealth of technical papers to be presented may be had from the tentative list of sessions and subjects which will make up the program.

Technical Sessions

Fuels Division: One session devoted to stoker and furnace performance with overfired jets.

Gas Turbine Division: Two sessions: One covering progress in the marine gas-turbine field and the second on matching of turbines and compressors and the concept of hydraulic efficiency as a measure of compressor and turbine performance.

Industrial Instruments and Regulators Division: One session devoted to analog computers and heat-conduction errors in low-temperature measurements.

Management Division: Will cover two topics at its session. These will be labor relations and small-plant management.

Power Division: Three sessions at which the following topics will be discussed: English power station; marine fouling; fatigue tests of various types of 300-lb ASA flanges; graphical method of piping flexibility analysis; flexibility of thin tubes; and others.

Process Industries: One session on low-temperature cycles and refrigerants and the new multipart valve.

Safety Committee: One session at which the following four safety problems will be discussed: (1) Job analysis as a factor in industrial accident prevention; (2) integration of safety in engineering-college curricula; (3) the ASME and the President's Highway Safety Conference; and (4) safety problems in the construction of the Connecticut River Bridge.

Machine Design Division: Two sessions for which three papers are being prepared. These are on cold-roll forming of sheet and strip; a new noiseless method for packaging granular materials into packaging containers; and some engineering problems associated with metals in elevated-temperature service.

Inspection Trips

The social program will consist of three luncheons, one dinner, and the banquet. Names of speakers will be published later.

In keeping with New London's maritime traditions three interesting inspection trips have been lined up. The U. S. Submarine Base across the Thames River in Groton, Conn., will hold open house for ASME members and guests. Members will be able to walk through submarines and inspect laboratories and hear lectures on submarine work. Visits are also planned to the U. S. Coast Guard Academy where officers are trained for the U. S. Coast Guard, and to the Electric Boat Company, where some of the finest submarines were built during the recent war. Trips are also planned to manufacturing plants producing printing presses, textile machinery, thermos bottles, and paper boxes.

The General Committee in charge of local arrangements for the 1949 Spring Meeting is composed of the following:

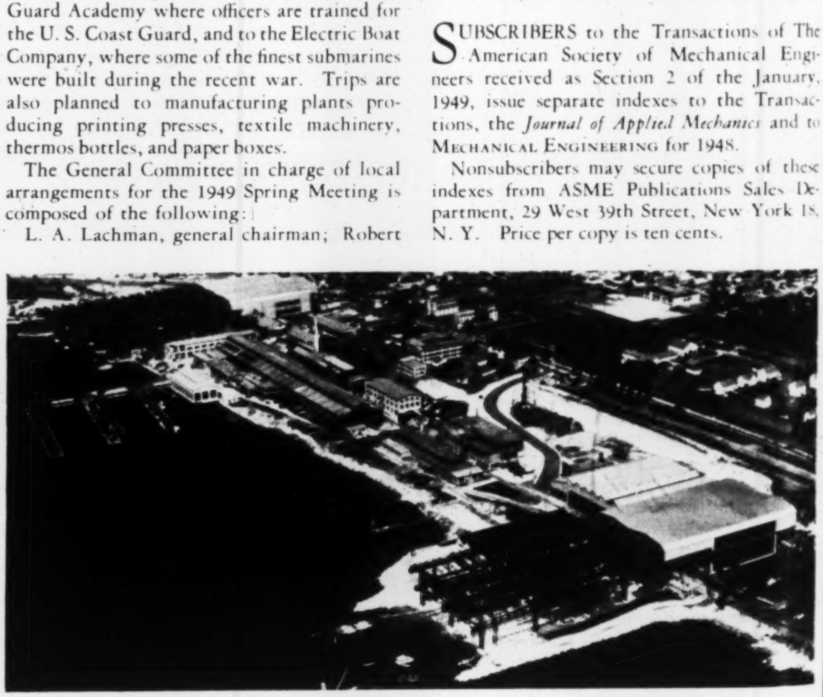
L. A. Lachman, general chairman; Robert Wosak, secretary; J. P. Heumann, assistant secretary. *Publicity Committee:* Willis F. Thompson, chairman; Gustave Welter, Michael J. Radecke. *Technical Events Committee:* Charles H. Coogan, chairman; David A. Fisher, Ronald S. Brand, John Parker. *Hotel Committee:* John S. Leonard, chairman; Frank T. Horan, J. Vincent Harrington. *Entertainment and Banquet Committee:* Thomas McM. Rianhard, Jr., chairman; Charles M. Warner, Walter E. Allan, Richard Simpson, H. R. Shailer, Jr.

Information and Registration Committee: William E. Hogan, chairman; Harry E. Harris, Winthrop H. Fry, Bruce McNaughton, C. W. Morse, George Brown, James L. Corcoran, James F. Young, John H. Palmer, Ernest A. Kroder. *Ladies Committee:* William E. Hogan, chairman. *Committee on Plant Trips:* Richard L. Weil, chairman; Nicholas A. Welch. *Committee on Printing and Signs:* Erich R. Stephan, chairman; Peter W. Rogan. *Reception Committee:* Edward H. Walton, chairman. *Exhibition Committee:* Albert S. Redway, chairman. *Finance Committee:* Albert C. Crownfield, chairman.

Indexes Available to 1948 ASME Publications

SUBSCRIBERS to the Transactions of The American Society of Mechanical Engineers received as Section 2 of the January, 1949, issue separate indexes to the Transactions, the *Journal of Applied Mechanics* and to MECHANICAL ENGINEERING for 1948.

Nonsubscribers may secure copies of these indexes from ASME Publications Sales Department, 29 West 39th Street, New York 18, N. Y. Price per copy is ten cents.



ELECTRIC BOAT COMPANY, GROTON, CONN., ONE OF THE INDUSTRIAL PLANTS TO BE VISITED DURING THE ASME 1949 SPRING MEETING TO BE HELD IN NEW LONDON, CONN., MAY 2–4, 1949

Board on Technology

YOU of the professional divisions committees represent one of the four functions of the technical life of the Society. In fact, in the exercise of your function you are in intimate contact with the members of the Society at large and they are more dependent upon you for the technical service which the Society renders than upon any other agency. That is because you are responsible for the formulation of the programs of the national meetings of the Society from which originates most of the technical material which goes to the members through the Society publications. That is a challenge which most divisions are meeting with credit. But it is a challenge which tolerates no complacency on your part. There is always room for improvement by exploiting the less developed branches of your fields and by keeping up the pressure for better papers.

Membership

Perhaps some of you are wondering what is this Board on Technology. You hear little about it directly. A look at its membership will give you a good idea of what at least some of its duties are. Among its members are the chairmen of the committees which administer the four principal functions of the technical life of the Society. These are the Professional Divisions Committee, the Meetings Committee, the Research Committee, and the Publications Committee. There are two members at large and a Council representative, a total membership of seven. Several other committees in charge of special projects report to the Board but are not represented on its membership.

In the Society By-Laws the Board's duties are stated as "supervision of the meetings of the Society (except business meetings), publications, divisions, and research activities." The By-Laws also permit Council to delegate for a period of one year its authority for the performance of its duties in respect to the policies affecting, and the procedures to be followed by, its member committees and the others assigned to it. A considerable list of specific duties was assigned to us under this authority last year and we expect that our responsibility for them will be renewed for the coming year. In carrying out these broadly stated duties the Board performs four main functions.

Functions

The first, and most obvious, is co-ordination of the activities of the committees under its supervision. The Board is a forum at which the representatives of the four committees can discuss their problems, come to mutual understandings, and keep their jurisdictional boundaries from becoming too indistinct. This has been a very useful function.

The second function is approval, under authority delegated to it by Council, of the recommendations of the committees under its supervision. This includes such matters as the number, size, location, and dates of the national meetings of the Society, and the location and dates of division conferences. Others pertain to the conduct of national meetings and matters of publication policy. The Board also passes on applications for new divisions.

The third function is formulation of policies relating to matters within the jurisdiction of the committees for which it is responsible. This is also under delegated authority.

The fourth function is initiation of projects designed to insure development and adequate coverage of the fields of technology within the scope of the Society's interests. This requires at once a broad view of mechanical engineering and a knowledge of the relation of mechanical engineering to new fields of technology as they develop. We must see the woods as a whole and see the trees too.

As now organized, the Board is well fitted to handle its co-ordinating function, but with the growth of responsibilities in other directions, particularly the third and fourth functions, its membership is lacking in continuity. So a By-Law[1] revision is up for final disposition at a meeting of the Council during the present Annual Meeting, the purpose of which is to increase the number of members at large from two to four and increase their terms from two to four years, retirements to rotate.

The four functions of the Board classify themselves into two groups. The first three are in the main administrative in character. At least, most of the matters which have to be dealt with at our meetings are of that character and the need for changes of policy is not frequent.

The fourth, or planning, function is of an entirely different type and does not lend itself to treatment in a meeting preoccupied with administrative details. So we are now arranging to hold an evening meeting after we have completed our routine agenda in the afternoon, at which some problem affecting the technological life of the Society is examined and recommendations formulated looking toward improvement. At these meetings we invite in guests who we believe may be able to assist us.

Problem of Nominations

The first problem we tackled was the broadening of the base of committee appointments. Too frequently the nominations of new members of standing committees and of executive committees of professional divisions are made in a hurry without a thorough canvass of the field. The Organization Committee has already done some excellent work in screening the nominees before appointment and in other ways. Our recommendations look to helping the committees in building up a backlog of tried candidates for committee appointments which reaches beyond those known to present committee members.

One of these suggestions is the appointment of a member of each committee as the nominating chairman, whose specific duty it will be to canvass the field and come up with a slate of, say, three nominees at the proper time. Another is to make use of subcommittees, where these are used, and of advisory or general committees otherwise, as probationary training schools for prospective committee members. The need is to keep a steady stream of new blood flowing into the technological veins of the Society.

But whatever we do, we need to keep the structure of the Society flexible so that it can adapt itself to the many conditions found in the large number of fields into which mechanical engineering is divided.

C. B. PECK, chairman,
Board on Technology

Better Society Conference

DURING the 1948 Annual Meeting the ASME Professional Divisions Committee invited members of the Council and Executive Committees of the various Professional Divisions to meet for a discussion of the topic, "Better Professional Divisions for a Better Society."

Following a brief statement by Past-Pres. E. G. Bailey, C. B. Peck, chairman, Board on Technology began the discussion by describing functions of the Board and telling of some of the problems confronting it. He was followed by G. A. Hawkins, chairman, Research Committee; Pres. J. M. Todd, who spoke as chairman, Board on Honors and Awards; P. W. Thompson, chairman, Meetings Committee; H. L. Dryden, chairman, Publications Committee; and W. L. H. Doyle, chairman, Professional Divisions Committee. Each of the chairmen told how his Committee contributes to a better society.

Mr. Peck's statement appears on this page. Statements of the other chairmen will be published in subsequent issues.

To Deans of Engineering Schools

THE Old Guard Committee of The American Society of Mechanical Engineers is considering preparation of a list of distinguished retired engineers, each of whom is pre-eminent in his field and willing to lecture at engineering schools on subjects pertaining to it.

Do you believe such a list would be of use to you? If enough favorable responses to this notice are received, the Old Guard Committee will undertake the project.

Remunerations is a secondary consideration.

Write to the Old Guard Committee, 29 West 39th Street, New York 18, N. Y.

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[1] Art. B6A, Par. 15 (Boards and Committees) was so amended by Council at its meetings on Nov. 28–29, 1948.

Railroad Dieselization to Be Theme of ASME 21st Oil and Gas Power Conference, April 25–29

RAILROAD dieselization will be the theme of the 21st National Oil and Gas Power Conference of The American Society of Mechanical Engineers to be held at the Hotel Sherman, Chicago, Ill., April 25–29, 1949.

In addition to a technical program packed with theoretical and practical interest to engineers and executives of the Diesel industry, the conference will feature a special preconference lecture series and an exhibit of Diesel engines, accessories, and instruments.

The preconference lecture program for which special registration will be required, will consist of a morning, afternoon, and evening session on Monday, April 25. Four eminent authorities will lecture on the subject "Gaseous Fluid Flow in Relation to Diesel Engine Design." John T. Rettaliata, Mem. ASME, dean, school of mechanical engineering, Illinois Institute of Technology, Chicago, Ill., will serve as moderator. Those wishing to attend the lectures should communicate with John C. Gibb, Socony-Vacuum Oil Company, 26 Broadway, New York, N. Y., for registration cards and other particulars.

Technical Sessions

Technical sessions of the conference will start Tuesday afternoon, April 26. Of timely interest are scheduled papers on the dual-fuel engine, the Bell cycle, Diesel locomotive radiator systems, Diesel engine turbocharging, vibration on valve mechanisms, and a full session devoted to the American Locomotive Diesel School with several papers by railroad men on Diesel schools and Diesel demonstrator cars as operated by the railroads.

The program is liberally interspersed with inspection trips of unusual interest, including railroad Diesel repair shops, a large manufacturer of Diesel locomotives, a large tractor plant and a prominent Diesel engine manufacturing plant.

High light of the conference will be the informal banquet Wednesday evening, April 27, with R. H. Morse, Jr., vice-president, Fairbanks, Morse and Company, acting as toastmaster and R. B. McColl, president, American Locomotive Company, as the after-dinner speaker.

The conference will be honored on this occasion by the presence of James M. Todd, president ASME, who will direct a few remarks to the banquet guests.

Diesel Engine Exhibits

Promising to be a larger attraction than ever before, will be the exhibits of Diesel engines, accessories and instruments. Hotel Sherman offers greater exhibit space than was available at former Oil and Gas Power Conferences. Letters of intent already indicate widespread interest on the part of exhibitors. Recognizing the educational value of these technical exhibits, the Committee has provided ample periods in the program for inspection of exhibits. The exhibits may be set up Monday, April 25. For information on exhibit space and rates write J. M. Clark, exhibit manager, ASME, 29 West 39th Street, New York 18, N. Y.

For variety of interest, with its keynote on railroad dieselization, the conference program is one of the best ever planned. Being held, as it is, in the center of the railroad and tractor industries, it should draw an unusually large attendance.

Make your reservations early. In writing to the Hotel Sherman for reservations mention the Oil and Gas Power Conference. The hotel has set aside a large block of rooms for the Conference.

ASME San Francisco Tour

June 18–July 11, 1949

JOIN the prominent group of ASME members who have already signed up for the tour. Just to know these people is worth the cost of the trip.

Along with the ASME Semi-Annual Meeting enjoy the incomparable beauty of the United States.

Revel in the grandeur of (1) Grand Teton National Park, (2) Grand Canyon National Park, (3) Yellowstone National Park, (4) 200-in. telescope at Mt. Palomar, (5) Yosemite National Park, and (6) Mount Rainier National Park.

Write the Secretary for an itinerary.

Changes to ASME Constitution, By-Laws, and Rules Become Effective at 1948 Annual Meeting

FOUR amendments to the Constitution of The American Society of Mechanical Engineers, approved by members of the Society by a count of more than 9000 in favor as against less than 75 in the negative, became effective Nov. 29, 1948, after results of the Aug. 19, 1948, letter ballot were officially reported at the 1948 Business Meeting.

Also during the Annual Meeting, the Council amended several By-Laws and Rules and proposed additional amendments which received first reading. By-Laws can be amended by Council without letter-ballot approval of the membership, but such amendments require two readings before they can be adopted.

The four amendments to the Constitution correct a situation by which members and Fellows who were elevated to the status of Honorary Members lost their corporate status; clarify the wording of one section; provide for flexibility in connection with holding Regional Delegates Conferences; and authorize adoption of the Canons of Ethics for Engineers as approved by the Engineers' Council for Professional Development.

For purposes of display, the ECPD has published the Canons on an attractive placard suitable for framing. The placard sells for 50 cents and is illustrated on page 103 of the January, 1949, issue of MECHANICAL ENGINEERING.

The amended sections follow:

Amendments to Constitution

Art. C3, Sec. 1. The corporate membership shall consist of Fellows, Members, Junior Members, *and Honorary Members when elevated from a corporate grade.*[1] In addition there shall be Honorary Members, Associates, and Student Members.

Art. C7, Sec. 5. The Council shall have power to fill vacancies in its membership by appointment until the next election, except that *in filling the office of President, the Council shall choose the Vice-President having the longest consecutive service as Vice-President. In case two or more have equal length of consecutive service as Vice-President, the one shall be chosen,* who is senior by length of corporate membership in the Society.

Art. C11, Sec. 2. The Sections shall be associated into geographical groups with annual meetings at which each Section shall be entitled to representation. Each geographical group shall be entitled to representation in a subsequent conference of group representatives *to be held annually.*

Art. C15, Sec. 1. In all professional and business relations the members of the Society shall be governed by the *Canons of Ethics for Engineers* incorporated in the By-Laws. (The Canons of Ethics for Engineers was published in full on pages 379 and 380 of the April, 1948, issue of MECHANICAL ENGINEERING.)

By-Laws Amended

At the 1948 Annual Meeting, Council adopted the following amendments to the By-Laws, all of which had been approved in the first reading at the meetings of the Council at the 1948 Semi-Annual Meeting in Milwaukee, Wis., May 30–31, 1948. The amendments to By-Laws follow:

Art. B6A, Par. 2. *The Council may delegate to the Boards established in the By-Laws,* for a period of one year, its authority for specific responsibilities for the performance of any duties required to be performed by the Council subject to any limitations prescribed by the Council. One member of each Board shall be a Director at Large appointed annually. The Chairman of each Board shall be entitled to a seat in the Council, without vote.

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[1] Italicized words indicate changes in wording.

Par. 12. This amendment substitutes the words "Constitution and By-Laws Committee" for "Committee on Constitution and By-Laws."

Par. 15. The Board on Technology, under the direction of the Council, shall have supervision of the meetings of the Society (except business meetings), publications, divisions, and the research activities. *The Board shall consist of nine (9) members; one (1) Director at Large, four (4) members at large, and a member (preferably the chairman) of the Meetings, Professional Divisions, Publications, and Research Committees. The four (4) members at large shall each serve for four (4) years and the term of one (1) member shall expire at the close of each Annual Meeting.*

Art. B9, Par. 1. A Semi-Annual Meeting shall be held upon the recommendation of the *Board on Technology* and authorization by the Council at its regular meeting at the previous Semi-Annual Meeting.

Par. 2. A General Meeting shall be held upon the recommendation of the *Board on Technology* and authorization by the Council.

Par. 5. All Meetings of the Society, except business meetings, shall be in charge of the Meetings Committee, under the direction of the *Board on Technology*.

Art. B13, Par. 1. All publications of the Society shall be in charge of the *Publications Committee*, under the direction of the *Board on Technolology*.

Art. B16, Par. 3. This amendment deletes the present paragraph 3, which states that in case of a tie vote on an amendment, the Presiding Officer at the Meeting of the Society shall cast the deciding vote," and changes the numbering of the present paragraphs 4 through 6 to paragraphs 3 through 5.

The Council also amended at its meeting on Nov. 29, 1948, Rule 10 of Article R4 (Qualifications for Admission) to make the Rule conform to current practice in Council balloting on applications for admission: The amended rule follows:

Art. R4, Rule 10. The Secretary shall mail to each member of the Council a ballot *and a list* of the names and respective grades of the *applicants for membership recommended* by the Admissions Committee after having been duly posted in the publications of the Society. The voter shall prepare his ballot by *leaving it unmarked to indicate approval of all candidates or by writing thereon the name* of any candidate *who is disapproved* by him, and shall enclose the ballot in an envelope and seal it. He shall enclose this envelope in a second envelope and sign it for identification. A ballot without the autographic endorsement of the voter on the outer envelope is defective and shall be rejected.

Proposed By-Law Amendments

The following additional amendments to the By-Laws have been proposed and received a first reading by the Council:

Art. B6A, Par. 14. It was proposed to delete this paragraph which provides for representation of the Society on the Library Board of the United Engineering Trustees, Inc., because provision for such representation is made in Art. B6B, Par. 4. Also proposed was the change of numbering of Pars. 15 through 18-A to Pars. 14 through 17-A.

To Retired Engineers

ARE you waiting to see your name in the obituary column or would you welcome an opportunity to be useful?

Would you like to lecture on an interesting subject to students in engineering schools? Would you enjoy helping young engineers by discussing current problems in your field of engineering against the rich background of your experience?

The Old Guard Committee of The American Society of Mechanical Engineers is considering a list of lecturers composed of retired ASME members who would enjoy lecturing at engineering schools on current problems in their special fields of interest.

If you can participate in such a project, write to the Old Guard Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Art. B6A, Par. 17-B. (formerly Par. 18-B) Proposed to read: The Membership Development Committee, under the direction of the Board on Membership, shall supervise the activities of the Society pertaining to membership extension. The Committee shall consist of a chairman and eight (8) members; one (1) member from each of the eight (8) Regions of the Society, nominated by the respective Vice-Presidents to serve *for the current term of the Vice-President nominating him. Members shall not serve more than three (3) consecutive terms by appointment. The Committee shall elect a chairman from those members who have not been renominated and such elected member shall thereupon serve an additional year.*

It was proposed to change numbering of Pars. 18-C through 20-A to Pars. 17-C through 19-A.

Art. B6B, Par. 4. Proposed to read: The Council shall designate the Society's representatives on the Library Board of the United Engineering Trustees, Inc., as required in the By-laws of that body.

Nominations Sought for ASME 1949 Awards

ALL members or agencies of the Society such as committees, Sections, or Professional Divisions, are encouraged to submit nominations for the various awards on or before March 1 of each year. Each nomination should be supported by the following: (1) Full statement of the training, experience, and notable contribution of the nominee; (2) statement of the basic reasons for submitting the nomination and for believing the nominee is eligible for the honor; (3) other information or reference which will assist the Board in considering the nominee.

Awards for 1949

Honorary Memberships. Five may be awarded each year. The Constitution provides the recipients shall be persons of "professional eminence." These awards are not limited to Society members. A nominee must be endorsed by 25 members.

ASME Medal. This award is made for distinguished service in engineering and science, and may be conferred in recognition of general service in science having possible application in engineering.

Holley Medal. The award is made for some "great or unique act of genius of an engineering nature that has accomplished a great and timely public benefit."

Worcester Reed Warner Medal. This award is made to honor the author of an outstanding contribution to permanent engineering literature. Permanent engineering literature may be a book, a series of books, a single paper, or a series of papers, which have been recognized as important additions to engineering literature by the profession.

For copies of a manual on ASME awards, write to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

One Engineer's Family

FOR an hour of hilarious reading, we recommend an excursion into the January issue of the *Ladies Home Journal*, "the magazine women believe in," where on page 34 begins the story of the remarkable Gilbreth family, condensed from the book, "Cheaper by the Dozen," by Frank B. Gilbreth, Jr., and Ernestine Gilbreth Carey, recently published by the Thomas Y. Crowell Company, New York, N. Y.

It is an engineering "Life With Father" which should fill homes and offices with roars of laughter.

ASME Calendar

of Coming Events

April 24–29
ASME Oil and Gas Power Division Conference, Hotel Sherman, Chicago, Ill.

May 2–4
ASME Spring Meeting, Hotel Mohican, New London, Conn.

June 27–30
ASME Semi-Annual Meeting, University of California, Extension Building, San Francisco, Calif.

Sept. 28–30
ASME Fall Meeting, Erie, Pa.
(Final date for submitting papers—May 1, 1949)

Nov. 27–Dec. 2
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers—Aug. 1, 1949)

(For Meetings of Other Societies see page 181)

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, B. H. EDELSTEIN, CHAIRMAN

Let's Not Neglect This Problem[1]

RECENTLY a college professor showed me a paper written by one of his graduate students—a young man employed as an engineer. From a survey of his own position and that of his colleagues in a number of companies, this young man had concluded:

"The forgotten man of our aggressive American civilization today is the so-called white-collar worker, who is neither able to penetrate the lower fringes of management nor fall into the category of trades people and production workers as encountered in organized labor.

"The 'average' graduate engineer is in a unique position. He works in an office removed from actual production areas, and is generally regarded as part of the higher-ups by both the factory workers and society in general. Yet the engineer is subjugated to every whim and fancy of management. He rarely has the opportunity to participate in determining company policies, conditions of work, and rates of pay. His grievances are seldom settled to his satisfaction, and he is open to the threat of discharge and blacklist if he undertakes to better his position as an individual. . . . . Out of many discussions, a conclusion was drawn . . . . . that until the day when a 'John L. Lewis' shall appear upon the scene and deliver his fellow engineers from the clutches of a static environment, the average engineer should try to gain employment with a firm that offers him the best possible advantages. It must be understood that such positions do not grow on trees but are found by a careful investigation, after which a diligent campaign to be employed by the concern must be conducted."

Disturbing Implications

This statement has disturbing implications for management, not the least of which is the tendency of the young man and his friends to look to a "John L. Lewis" for deliverance. Already there has been some movement toward unionization in professional fields, and while it is negligible as yet, it is a development to be watched. It would be fine to see management locking the stable door while the horse was still inside for a change. In the case of foremen, management got a second chance—through the Taft-Hartley Act—to correct its procedures and to show that it meant what it said when it claimed the supervisors were part of management. Now, even if the section of the Act dealing with foremen's unionization should be repealed, most companies are much less vulnerable on this score than they were a few years ago.

Double-Edged Tools

FORMULAS are useful engineering tools, but poison to education—a substitute for thinking.[2]

But as things stand at present, it would be unwise to count on such second chances. Management did not get one in the case of production workers, it will be remembered.

Perhaps it might be thought that this young man is just a natural-born malcontent, or possibly one whose experiences have simply happened to be on the unfortunate side. I do not think the evidence points that way; I have heard similar complaints from other sources.

What, then, are the objectives of the young engineer? What are the economic opportunities he seeks, and possible adjustments management may make to meet his needs?

Fair Play

First of all the young engineer wants fair play. There have been many complaints on this score—low starting salaries, slow raises, inadequate remuneration considering his professional status and the length of time he has put in preparing for his career, inadequate differentials over the pay of the organized hourly rated employees, too bit a spread between the engineer and his superior. Grievances have arisen over companies' patent policies.

A satisfactory pay policy would seem to call for starting pay and base pay in line with the recommendations of the professional societies, and based on a good job-evaluation plan always kept up to date. An important element in the engineer's pay, also, should be fringe benefits—insurance for sickness, accidents, old age and death, occasional leaves of absence. Careful consideration needs to be given to incentives. An annual bonus might be paid for good performance, a special bonus for special accomplishments. In addition, companies might consider a more liberal patent policy. Groups and individual engineers might put forth special effort if some kind of recognition were afforded by the company, perhaps in the form of a bonus.

Chance for Advancement

Second, most people want a job that utilizes their capacities to the utmost. Yet at times engineers are put into routine jobs which could be equally well performed by persons with less specialized education. Another frequently mentioned grievance is lack of chance for advancement, and the haphazardness of the promotion procedure. Finally, much ill-feeling is aroused by the practice of having research-minded engineers report to production-minded executives who expect results daily.

Many of these difficulties might be eliminated by a system of "management alignment" under which engineers would be allocated proper managerial functions corresponding to their capacities. The feeling of being "buried in oblivion" might be alleviated by a personnel inventory describing the nature of the job, the responsibilities of the individual, and his performance, with a regular follow-up by a member of higher management. Training efforts are, of course, of great importance. The supervision of engineers might be more advantageously placed in the hands of men familiar with their needs, who could, to some extent, protect them against those overly concerned with immediate results.

Recognition and Prestige

Recognition and prestige are, of course, especially important for any professional and often serve to compensate for other disadvantages attached to the job. The engineer, even more than other employees, resents being only one of many. As an illustration of what might be done, companies might consider giving more widespread permission for individuals or groups of engineers to publish findings where such publication would not be harmful to basic company interests. Leaves of absence to attend professional meetings, or possibly some university refresher courses, and regular meetings of the scientific personnel at the plant for presentation and discussion of papers all seem to contribute to job satisfaction.

Metropolitan Juniors Offer Award

THE Junior Group of the ASME Metropolitan Section announces that it is sponsoring a competition for the best paper written by a Junior in the Metropolitan Section.

A cash prize of $25.00 will be awarded for the most original, timely, and best-composed paper of interest to engineers. All papers must be submitted by March 15, 1949.

For further information contact the Metropolitan Section Junior Group at ASME Headquarters, 29 West 39th Street, New York 18, N. Y.

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[1] "President's Scratchpad," by Lawrence A. Appley, Assoc. ASME, President, American Management Association. Reprinted from *Management News*, Nov. 30, 1948.

[2] New Proverbs for Young Engineers, by Philip W. Swain, editor, *Power*, McGraw-Hill Publishing Company, Inc., New York, N. Y. Mem. ASME.

Finally, free expression of opinion and fair treatment are rights that all democratic citizens expect in all phases of their activities, including their jobs. Yet one hears a good deal of complaint on the part of the engineers that their superiors are not sympathetic. The engineers say that they have no access to higher management, do not understand company policy properly, and are not consulted about it, cannot voice their suggestions and grievances properly. This difficulty might be overcome by regular formal or informal meetings between the engineers and various members of higher management. Some thought might also be given to improving the methods of airing complaints.

If businessmen—the industrial management leaders of today—expect to find qualified hands in which to place the future of their business and the nation's economic health, they cannot sit back and wait for tomorrow's engineers to come knocking at their office doors. They must actively engage in their development—now.

Letters

Job Opportunities

To the Editor:

ALTHOUGH I am a junior member of only two months' standing, I feel that I can give a satisfactory answer to Mr. Weiss's questions on the subject of job opportunities[3] about which he wrote in the December, 1948, issue of MECHANICAL ENGINEERING. I would also like to pass along to the student members a few bits of practical information on the subject of job opportunities for new graduate engineers.

From what I have seen and experienced, I would say that American industry is fairly and capably handling the job of absorbing new engineers into its network. The universities and colleges of our country also are sharing admirably in this endeavor.

From what Mr. Weiss has said, I believe that he has missed the boat in waiting until he returned to New York before he proceeded to look for a job. Surely the University of Michigan, as all prominent universities, has a student-placement bureau where graduating seniors have the opportunity to be interviewed for a job by representatives of many national, sectional, and local industries. If one does not avail himself of that opportunity, then the fault lies certainly with him; for I will agree that it is difficult, if not impossible, for a new engineer to get a job merely by shopping around the employment agencies in his home town.

Perhaps this unfortunate, yet understandable, situation should receive more publicity, and the Junior Forum might well undertake this important task. The fact to be driven home to the student member is that he should seriously consider every job that is offered to him by the representatives of industry who visit his school. They are usually the only group of employers who take inexperienced engineers and give them that chance to gain experience which is so vital to the youthful engineer who desires to progress and contribute to his profession. It is folly to assume that a small firm will spend its time and money breaking in a newcomer when experienced men are available.

Let me urge again that while the student member is still under the friendly wing of his school, he should make his inquiries about job opportunities and not wait until he is on his own before he looks for a job. There are many fruitful jobs open to young engineers, but the man must be there when jobs are offered and they are offered at the school before graduation. Don't miss the boat and complain later.

NORMAN R. ADOLPH.[4]

Philadelphia Junior Group Well Organized for 1949

To the Editor:

IN THE Philadelphia Section there are a sufficient number of junior members to permit us to have a Junior Group. This Group functions as an integral part of the Philadelphia Section, and the administration of its affairs is the responsibility of the Junior Group Executive Committee composed of the following: Robert E. Derby, chairman; Walter F. Coles, Jr., vice-chairman; Russell T. Vogdes, Jr., secretary-treasurer; H. Donald Moll, program; William H. Peirce, membership; William E. McLaughlin and Stephen P. Higgins, Jr., student relations; Mario Pierpoline, entertainment; and John L. Lewis, publicity.

Section Provides Funds

The activities of the Junior Group are supported by funds made available by the Section; however, we hold our own monthly meetings and prepare our own program. In order that our meeting subjects will not conflict with those of the Section, Professional Divisions, and Trenton and Wilmington Sub-Sections, they are subject to the approval of the Section program co-ordinator. In this way we present the ASME members of the Philadelphia area with a meeting program that covers a maximum amount of technical information, and avoids any duplication of presentation or discussion. In our Junior Group program for the 1948–1949 season we have included the subjects of general science, photography, power, paper making, and product design.

Our meetings are held at the Engineers' Club, and are preceded by a dinner. Our average attendance is 75.

Relation With Student Branches

This year one of the primary objectives of our Junior Group is to establish a close relationship with the student branches in the near-by schools of the University of Pennsylvania, Drexel Institute of Technology, Swarthmore College, and Villanova College. To accomplish this objective a member of our Student Relations Committee attends the student-branch meetings and does everything possible to assist them in their program. In addition, each month we have the student honorary chairman and the student chairman from one of the colleges as our guests at the meeting and the dinner.

Feature Events

The outstanding feature of our junior-student program is a student night, when the juniors are hosts to the student members from each of the four colleges. At this meeting the entire Philadelphia Section gives us some excellent assistance by having a member present to act as a sponsor for each student, and to have the student as his guest at dinner. At our student night last year, there were 261 members, juniors, and students present, which was the maximum number that it was possible for us to accommodate. By maintaining such a close relationship with our student branches we hope to increase the number of those graduates transferring to junior membership and accordingly, in the case of those graduates who remain in this area, increase the size of our Junior Group.

With the thought in mind that it is good for all junior engineers to become better acquainted with each other, we are planning this year to have a joint meeting with the members of the Junior ASCE Group in Philadelphia. We hope to be able to enlarge the scope of this meeting next year and include the members of the junior Groups from the AIEE and the Engineers' Club.

Support for Junior Forum

We are doing everything possible this year to assist with the Junior Forum, and whereas to date we have not been able to obtain any contributions we are in hopes that our endeavors will produce some results in the near future. As an example of one of our efforts in this regard, a circular, prepared by John L. Lewis, our publicity chairman, urging contributions to the Forum, was distributed at our last meeting. At every meeting we invite the attention of our members to the Junior Forum.

We place a great deal of emphasis upon the activity of our Membership Committee under the direction of its chairman, Bill Peirce. This Committee maintains a directory of the junior members in this area, and prepares a complete report each month as to the number and names of those in attendance at our meetings. As a result of these records we are able to keep a close check on the interest of our various juniors, and to obtain the assistance of those who are most active in the carrying out of our program and the many jobs in connection therewith.

Here in Philadelphia we believe that we have a very fine and active Junior Group, and we are anxious to better our organization wherever possible. Accordingly, we would welcome any comments or ideas that other Junior Groups have employed in their programs.

ROBERT E. DERBY.[5]

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[3] "Job Opportunities," by David H. Weiss, MECHANICAL ENGINEERING, vol. 70, December, 1948, p. 1041.

[4] Graduate Student, Yale University, New Haven, Conn. Jun. ASME.

[5] Chairman, Junior Group, ASME Philadelphia Section, Albert C. Wood and Associates, Philadelphia, Pa. Jun. ASME.

Members Express Enthusiasm for ASME Town Hall Broadcast

Recordings Available

JUDGING from the shower of congratulatory letters and telegrams which came upon the ASME Engineers Civic Responsibility Committee just before and after the America's Town Hall Meeting of the Air broadcast and telecast of Nov. 30, 1948, this feature of the 1948 Annual Meeting of The American Society of Mechanical Engineers was one of the most popular sponsored by the Society.

The ASME Town Hall session was a panel discussion on the topic, "Are Our Ideals Being Destroyed by the Machine Age?" Two engineers, William L. Batt, past-president and Hon. Mem. ASME, and Leonard J. Fletcher, advisory member of the ASME Engineers Civic Responsibility Committee, spoke for the negative side, while two eminent nonengineers, John Haynes Holmes, pastor of the Community Church of New York and Clark G. Kuebler, president, Ripon College, Ripon, Wis., took the affirmative side. That the topic was well chosen and the arguments of the speakers provocative was evident in the enthusiastic response from 35 sections and student branches whose requests for reprints of the broadcast quickly exhausted the available supply of 6000 copies.

Recordings Available

Members who wish to plan future programs on the topic of the broadcast need not be disappointed for while reprints have been exhausted, the Engineers Civic Responsibility Committee has preserved the entire broadcast on two 33-rpm recordings which may be obtained by writing to F. A. Faville, chairman, ASME Engineers Civic Responsibility Committee, 105 West Adams Street, Chicago 3, Ill.

Dinner Meeting in Chicago

Although word of the broadcast was announced only a few weeks in advance of the Annual Meeting and after sections and student branches had completed the schedule for fall meetings, some of the sections called special meetings on short notice to listen to the broadcast and to continue the discussion. Fifty members and guests of the Chicago Section at a special dinner meeting continued discussion of the topic well over an hour after the broadcast. William A. Dundas, general superintendent, The Sanitary District of Chicago, Chicago, Ill., who served as moderator, urged in his introductory remarks that engineers put aside their aversion to politics and actively seek public office.

Forty members of the ASME Southern Methodist University student branch heard the broadcast and immediately wrote for reprints. The Columbia University student branch was fortunate in having its regular meeting fall on Nov. 30. In the Syracuse Section where the regular meeting was scheduled for Dec. 1, members were alerted by mail and came prepared on the following evening to discuss civic responsibility.

The Society is indebted to the Engineers Civic Responsibility Committee and its chairman, F. A. Faville, president, Faville-LeVally Corporation, Chicago, Ill., whose initiative made the broadcast a reality. Other members of the Committee are W. E. Johnson, P. W. Nordt, Jr., David Larkin, and S. M. Dean.

ASME Master-File Information

Please Print **Check Mailing Address**

Name...
Last First Middle

Home Address.. ☐
Street City Zone State

Name of Employer..

Address of Employer... ☐
Street City Zone State

Product or Service..

Title of Position Held..

Nature of Work Done...

Notify Headquarters Promptly of Changes

ASME 1948 Membership List Available

THE 1948 Membership List of The American Society of Mechanical Engineers was released in January, 1949, and is available free to members of the Society upon written request.

The Membership List contains photographs of Society officers and members of the Council, information about the Society, alphabetical and geographical list of members and list of ASME student branches.

Information about each member includes his grade of membership, Professional Divisions affiliation, title, business address and in many cases a mailing address.

Reflecting the growth of the Society since the issue of the last Membership List in 1946, the current issue is exactly 100 pages more in length and contains information on approximately 25 per cent more members.

For purposes of economy only a limited number of copies of the 1948 Membership List was published. These will be distributed to officers and committee personnel of the Society and, while the supply lasts, to members who ask for copies.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Birmingham, Nov. 15. Speaker: Don V. Ericson. Attendance: 51.

Boston, Dec. 16. Speaker: F. R. Benedict. Attendance: 110.

Chicago (Junior Group), Dec. 7. Speaker: W. R. Burrows. Attendance: 81.

Dec. 15. Joint meeting of Product Design Division and Metals Engineering Division. Speaker: J. J. Kanter. Attendance: 56.

Cincinnati, Dec. 2. Speaker: S. E. Heymann. Attendance: 34.

Kansas City, Dec. 13. Speaker: Linn Helander, vice-president, ASME Region VIII. Attendance: 62.

Milwaukee, Dec. 8. Speaker: Charles E. Cunningham. Attendance: 40.

Minnesota, Jan. 5. Inspection trip to plant of Waldorf Paper Products Company, St. Paul, Minn.

New Haven, Dec. 8. Speaker: Ernest Kehr. Attendance: 40.

New Orleans Dec. 13. Speakers: A. H. Jensen and J. F. Vogt. Attendance: 97.

Dec. 17. Speaker: J. M. Todd, president ASME. Attendance: 48.

North Texas, Dec. 9. Inspection trip to plant of Procter & Gamble, Dallas, Texas. Attendance: 37.

Philadelphia, Dec. 14. Speaker: Commander E. S. McCawley. Attendance: 96

Rock River Valley, Nov. 18. Speaker: J. F. Roberts. Attendance: 60.

Savannah, Dec. 14. Speaker: J. E. Tobey, president, Appalachian Coals, Inc. Attendance: 28.

South Texas, Oct. 29. Dinner and inspection trip as guests of Humble Oil and Refining Company, Baytown, Texas. Attendance: 172.

Syracuse, Nov. 8. Speaker: E. G. Bailey, president ASME. Attendance: 235.

Dec. 1. Speakers: John Detore and Alan Chadwick. Attendance: 93.

Western Washington, Dec. 1. Speaker: Allen S. Cary. Attendance: 87.

Worcester, Dec. 2. Speaker: R. T. Holland. Attendance: 38.

Student Branch Activities

Reports of the following ASME student branch meetings were received recently at Headquarters:

University of Arkansas, Dec. 2. Showing of film "Tornado in a Box." Attendance: 49.

University of California, Nov. 26. Speaker: Alfred G. Cattaneo. Attendance: 99.

Catholic University, Dec. 9. Speaker: R. L. Goetzenberger, Minneapolis-Honeywell Regulator Co. Attendance: 20.

Clemson College, Nov. 22. Speaker: W. L. Skidmore. Attendance: 230.

Columbia University (Mechanical Division) Nov. 1. Speakers were members of the branch who talked on their summer jobs in industry. Attendance: 45.

Dec. 9. Technical employment forum. Speakers: J. K. Finch, dean of the engineering school at Columbia, and Mr. Moore, director of Columbia Placement Bureau. Attendance: 145.

Cooper Union (Day), Dec. 6. Speaker: Prof. Victor Paschkis, Columbia University. Attendance: 38.

Dec. 14. Speaker: Mr. Swick. Attendance: 33.

Cornell University, Dec. 2. Program of films on steam power plant accessories and aluminum. Attendance: 100.

Dec. 10. Joint meeting with AIEE. Speaker: Professor Jones. Attendance: 35.

Dec. 14. Speaker: Professor Ballard. Attendance: 58.

George Washington University, Dec. 1. Showing of two films. Attendance: 45.

Illinois Institute of Technology, Nov. 30. Two films shown. Attendance: 175.

Dec. 9. Speaker: H. E. Peyrebrune. Attendance: 50.

University of Illinois, Dec. 1. Speaker: Gordon White. Attendance: 98.

State University of Iowa, Nov. 17. Speaker: Ray Hudachek.

Dec. 1. Talks by students Robert Adams and Mr. Lemont.

Dec. 8. Speaker: William R. Parmen.

University of Kansas, Dec. 2. Film on steam progress. Attendance: 115.

University of Kentucky, Nov. 23. Special meeting of officers of the branch.

Dec. 2. Speaker: Mr. Tenney.

Dec. 9. Speaker: Mr. Meyer.

Lafayette College, Dec. 9. Speaker: J. C. Groff. Attendance: 63.

Lehigh University, Dec. 9. Speaker: H. J. Clyman. Attendance: 110.

University of Maine, Dec. 15. Speakers: Prof. H. Watson, Prof. Feener, and Prof. Lee. Attendance: 40.

Marquette University, Dec. 2. First meeting of new quarter. Talk by Professor Schoen, honorary chairman. Attendance: 200.

Dec. 22. Speaker: Al Zack. Attendance: 80.

University of Michigan, Dec. 8 and 9. Field trip to Kaiser-Frazer Corporation. Attendance: 145.

Dec. 15. Three films shown. Attendance: 75.

Mississippi State College, Nov. 18. Joint meeting with student branch, University of Alabama. Film on steelmaking shown. Attendance: 10.

Dec. 2. Speaker: Carl B. Fritsche. Attendance: 47.

Missouri School of Mines, Dec. 7. Speaker: A. J. Lyster. Talk illustrated with sound film on lubrication of gears and bearings. Attendance: 202.

University of Nevada, Nov. 30. General business meeting. Attendance: 9.

New Mexico State College of A&M Arts, Dec. 2. General business meeting. Attendance: 35.

Dec. 7. Speaker: T. A. Boyd. Attendance: 50. Also field trip to the Darbyshire Foundry, El Paso, Texas.

Northeastern University, Dec. 9. Technicolor film "Treasure From the Sea." Attendance: 82.

Northwestern University, Nov. 2. Joint meeting with AIEE, IRE, ASCE, and AIChE under the Engineering Societies Council. Speaker: J. F. Downie Smith, dean of engineering, Iowa State College. Attendance: 350.

Dec. 2. Election of officers, for spring and fall quarters, 1949. Attendance: 55.

University of Oklahoma, Nov. 24. Speaker: Paul A. Cushman. Attendance: 110.

Pennsylvania State College, Dec. 1. Film, "Wheels for the World." Attendance: 83.

University of Pittsburgh, Sept. 23. Speaker: Daniel L. Janoff. Attendance: 197.

Oct. 14. Speaker: H. A. Brown, The Mesta Machine Corporation. Attendance: 197.

Polytechnic Institute of Brooklyn (Day), Dec. 14. Speaker: L. E. Fuller. Attendance: 104.

Rensselaer Polytechnic Institute, Nov. 18. Speaker: Thomas Linville. Attendance: 115.

Rhode Island State College, Nov. 4. Speaker: Mr. Wagner, Providence Gas Company. Attendance: 50.

Dec. 8. Speaker: Mr. Walsh, Narragansett Electric Company. Attendance: 62.

Stanford University, Nov. 23. Speaker: Frank Maker. Attendance: 28.

U. S. Naval Academy (Midshipman School), Nov. 6. Inspection trip to Martin Aircraft plant. Attendance: 75.

Nov. 10. Film, "Copper Goes to War."

Nov. 11. Inspection trip to David Taylor Model Basin, Carderock, Md.

Nov. 25. Film in color on art of generating and gear-manufacturing equipment.

Dec. 1. Film of the Stokes Company.

Dec. 8. Film on the development of the helicopter.

Dec. 15. Speaker: Dr. Emil Ott.

Villanova, Dec. 9. Field trip to plant of the Lukens Steel Company, Coatesville, Pa.

Virginia Polytechnic Institute, Dec. 7. Speaker: James M. Todd, president ASME. Attendance: 450.

Washington University, Nov. 24. Annual dance, "Steam Men's Strut." Attendance: 200.

Dec. 13. Speaker: Meade McArdle. Attendance: 40.

Dec. 20. Field trip to McDonnell Aircraft Company and trip through the Lincoln-Mercury assembly plant. Attendance: 122.

Wayne University, Dec. 2. Speaker: Sigurd Nepstad. Attendance: 63.

University of Wisconsin, Dec. 15. Speaker: C. W. Gamerdinger. Attendance: 50.

Worcester Polytechnic Institute, Jan. 11. Inspection of Alden Hydraulics Laboratory at Chaffins. Speaker: Prof. Leslie J. Hooper.

ASME Sections

Coming Meetings

Anthracite - Lehigh Valley: February 25. Scranton Meeting. Subject: Instrumentation. Speaker to be announced.

Atlanta: February 18. Georgia Tech Dining Room at 6:30 p.m. Dinner Meeting. Program arranged by Student Section, supervised by Dr. Weber and Prof. Vidosic.

Boston: February 24. Forum Meeting. Subject: Engineering Economics. Speaker to be announced.

Cincinnati: February 3. Joint Meeting with AICE. Subject: Conveying Equipment, by Speaker from Link-Belt Company.

Hartford: February 15. City Club at 6:30 p.m. Subject: Atomic Power, by Cuthbert Daniel, consultant for Hydrocarbon Research, Inc.

Kansas City: February 14. University Club. Dinner at 6:30 p.m., Meeting at 8 p.m. Subject: Background and Future Use of Atomic Energy, by F. R. Gruner, research and development engineer in basic industry department, Allis-Chalmers Manufacturing Company.

Metropolitan Section: February 3. Machine Design Division, Metropolitan Section and New York District of ASTM, Room 501[1] at 7:30 p.m. Subject: Aluminum and Its Application in Machine Design, by Richard L. Templin, Assistant Director of Research and Chief Engineer of Tests, Aluminum Company of America, also President of ASTM.

February 8. General Interest Meeting, Room 501[1] at 7:30 p.m.

February 10. Women's Auxiliary, Engineering Woman's Club, 2 Fifth Avenue, New York, N. Y. Luncheon at 12:30, Meeting at 2 p.m. Subject: Significance of the Rh Blood Factor, by Dr. Austin Joyner, Director, Department of Medical Research, Lederle Laboratories.

February 15. Engineers' Forum, Room 1101[1] at 7:30 p.m. Subject: The Engineer Looks at Labor Union Contracts. Informal discussion.

February 17. Photographic Group, Room 1101[1] at 7:30 p.m. Subject: Incident Light and Its Relation to Exposure, by Charles H. Coles, Chief Engineer, American Bolex Company, Inc.

February 24. Industrial Instruments and Regulators Division, Room 1101[1] at 7:30 p.m.

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[1] Engineering Societies Building, New York, N. Y.

Subject: Some Fundamentals of Automatic Control as Applied to the Process Industries, by Warren W. Matlack, Brown Instrument Division, Minneapolis-Honeywell Regulator Company.

February 25. Management Division, Room 502[1] at 7:30 p.m. Subject: Industrial Relations and the Goals of the American People, by Russell A. Ziegler, Manager, Public Relations and Market Research, Cluett, Peabody and Company, Inc.

Minnesota: February 2. Section Meeting. Subject: New Products—The Key to Industrial Progress, by Arthur D. Hyde, president of mechanical division, General Mills, and C. W. Walton, new products manager, Minnesota Mining and Manufacturing Company.

Ontario: February 10. Music Room, Hart House at 8 p.m. Subject: Mechanical Engineering Applications of Industrial Electronics, by W. M. McKie, Canadian General Electric Company, Ltd.

Peninsula: February 8. Joint Meeting with other national societies in this area, at 8 p.m. Possibly a split meeting with part taking place in Kalamazoo-Battle Creek area and part in the Muskegon area.

Philadelphia: February 9. Engineers' Club of Philadelphia. Joint Meeting with ASCE.

February 15. Towne School, University of Pennsylvania. Professional Division Meeting. Subject: Stress Determination by SR-4 Gages, by Frank Tatnall, Baldwin Locomotive Company.

February 18. Engineers' Club. Subject: Foundation of New Chemical Industries From Petroleum Refining, by Dr. C. G. Kirkbride, vice-president for Research and Development, Houdry Process Corporation.

Plainfield: February 16th. Elk's Club, Elizabeth, N. J. Subject: Plastics in Industry. Speaker: John J. Kebille, Jr., plastics division, Celanese Corporation, New York, N. Y.

Southern California: February 2. Hydraulic Division, California Institute of Technology, Pasadena. Subject: Good Practice in Piping Design and Layout, by Peter Kyropoulos and A. Wood.

Feburary 7. Photographic Division, California Institute of Technology, Pasadena. Subject: Study of Hydrodynamic Problems Using High Speed Photography, by Donald Peterson and Hirshell Shapiro.

February 8. Rio Hondo Country Club. Subject and Speaker: See February issue of *Engineer* for details. Process Industries Division Meeting.

February 9. Rio Hondo Country Club. Subject: Fundamentals of Instrumentation, by Major Behar. Instruments and Regulators Division Meeting.

February 9. California Institute of Technology, Pasadena. Subject: Equipment Specifications, by H. Arthur Price and Anthony Hunter. Hydraulic Division Meeting.

February 9. University of California, Los Angeles. Subject: Solution to Laminar Boundry Equations, by Lyle Moore. Heat Transfer Division Meeting.

February 11. University of California, Los Angeles. Subject: Fracture and Notch Brittleness, by Egon Orowan. General Meeting.

February 12. Process Industries Meeting. See February issue of *Engineer* for details.

February 16. California Institute of Technology, Pasadena. Subject: Pump Specifications, by Perry Brown. Hydraulic Division Meeting.

February 16. General Meeting. San Diego Women's Club. Subject: Instrumentation, by S. S. Williams.

February 22. Process Industries Meeting. See February issue of *Engineer* for details.

February 23. California Institute of Technology, Pasadena. Subject: Construction Specifications, by Anthony Hunter. Hydraulic Division Meeting.

February 23. Field Trip. San Diego. Consolidated Vultee Aircraft Corporation. Speakers: Milton G. Northrup and C. T. Geiger.

Southern Tier: February 28. Hotel Frederick, Endicott. Subject: Physical Testing, by F. G. Tatnall, Baldwin Locomotive Works, Eddystone, Pa.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph Street

Detroit
100 Farnsworth Ave.

San Francisco
57 Post Street

MEN AVAILABLE[1]

Production Engineer, 22, single, BSME, one year graduate study industrial engineering; 2 years college instructing and research; 15 months as planner for corrugated paper company. Works well with others. Available immediately. Central or Northern California. Me-372-487-D-22.

Mechanical Engineer, 33, single, former Canadian Army technical officer, one year expediting aircraft manufacture, over 3 years as engineering university instructor, desires American opportunity. Available April 15, 1949. Me-373.

Industrial Executive, 39, married; ME N. Y. License, 20 years' experience industrial management and maintenance. Design, layout, production, methods, costs, personnel. Much labor relations. Law degree. West Coast. Me-374-4812-D-4.

Mechanical Engineer, 32; 11 years' varied manufacturing experience mainly electromechanical instruments. Production, design, methods and liaison engineering background. Me-375.

Mechanical Engineer, 27, MIT graduate; one and a half years mechanical drafting and design; one and a half years general plant engineering in large basic steel plant. Eastern U. S. Me-376.

Industrial Engineer, BME, 25, married, MS in administrative engineering pending. Four years' production and plant-design experience along mechanical and electrical lines, desires production or management-control position with future. Me-377.

POSITIONS AVAILABLE

Industrial Engineer, preferably with degree in industrial or business administration, not over 35, with experience in industrial-management work. Some traveling. Salary open. Ohio. Y-1908-D.

Instructor, mechanical graduate, well acquainted with mathematics, mechanics, kinematics, engineering design, mechanical design, and tool design: Need not have previous teaching experience. Salary open. Pennsylvania. Y-1909.

Industrial Engineer, under 55, engineering graduate, with general production experience in metal-fabrication industries, to make plant surveys covering buildings, power plant, machine tools, and heavy equipment to determine suitability for manufacture of aircraft frames, engines, etc. Considerable traveling. $6200. Headquarters, New York, N. Y. Y-1922.

Mechanical Engineer, 38–45. Must be experienced in all phases of flour-milling process and equipment. Must also possess knowledge of mill-equipment layout and mill construction. Salary open, depending on qualifications. New York, N. Y. Y-1929-R-5396.

Sales Engineer, 30–40, mechanical graduate, with thorough training in heat-exchanger rating and at least 5 years' sales experience calling on oil, chemical, and engineering concerns to take charge of Eastern sales program for Midwest manufacturer. $7500-

(*ASME News continued on page 196*)

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[1] All men listed hold some form of ASME membership.

CHECK

YARWAY
YARNALL-WARING CO. PHILADELPHIA, PA.
H
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LIQUID LEVEL
INDICATOR
SERIAL
UNIT
PRES.
PATENT APPLIED FOR

BOILER WATER LEVELS *at* EYE LEVEL

Boiler water level readings are brought right down to eye level—on the instrument panel or any other place in the power plant—with the Yarway Remote Liquid Level Indicator.

Indication is *instant* and *accurate* because indicator is operated by the boiler water itself. Mechanism is never under pressure. There are no stuffing boxes—operation is frictionless. Complete separation of indicating and actuating parts is obtained by permanent magnet transmission.

Yarway Remote Indicators are used not only for boiler water level readings, but also for other liquid levels.

FOR COMPLETE DESCRIPTION WRITE FOR BULLETIN WG-1822

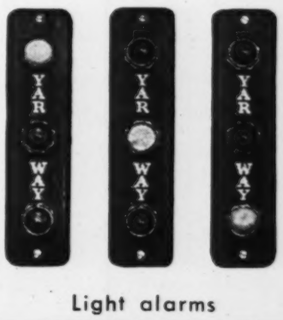
•

YARNALL-WARING COMPANY
108 Mermaid Avenue
Philadelphia 18, Pa.

NEW CONTROL UNIT PROVIDES REMOTE SIGNALLING

Yarway Indicator, when equipped with new Control Unit, operates additional horn or light alarm signals anywhere in the power plant. Control Unit may also be used as control for mechanical equipment.

Horn alarms



YAR
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WAY

Light alarms

YARWAY REMOTE LIQUID LEVEL INDICATOR

$9000. Headquarters, New York with numerous trips to Boston, Philadelphia, and other industrial centers. Y-1942.

Mechanical Engineer with minimum of 5 to 10 years' experience in design, installation, and operation of facilities equipment, boiler plant, etc., for various industries, i.e., sugar, paper mill, and textile mill. Position will involve considerable traveling. $10,000. Headquarters, New York, N. Y. Y-1950(a).

Engineers. (*a*) Production engineer, under 45, mechanical or industrial engineering degree. Must have experience in welding and machining of heavy ferrous metals. Will be in charge of methods and procedures, tooling, materials handling, and allied operations. About $12,000. (*b*) Plant engineer, 35–40, mechanical or industrial engineering degree. Must know power-plant and machine-shop operations. Must have experience in welding and machining of heavy ferrous metals. $9000. Upstate New York. Y-1954.

Senior Mechanical Engineers to do general engineering, plant layout, equipment design, and power-plant work. Starting about $4500–$5100. Ohio. Y-1970-D.

Mechanical Engineer with 18 to 20 years' experience on general piping hook-ups and installations, such as heat, water, gas, oil, chemical, power plant. Turbine, superheat, ventilation, precipitators, etc. Graduate engineer, field experience. Consulting experience. $6000–$7200. Pennsylvania. Y-1971(b).

Building Maintenance Assistant, 30–45, preferably mechanical graduate with institutional or furniture equipment experience, to plan layout of wood and metal desks, cabinets, etc., prepare specifications, schedule maintenance, etc., covering hospital facilities. $4160–$4680. New York, N. Y. Y-1986.

Engineers. (*a*) Mechanical engineer, with at least 3 years' experience on design and development of warm-air heating equipment, to design and lay out improved types of domestic furnaces. $4160–$5200. (*b*) Engineering draftsman, mechanical graduate, with sheet-metal products experience, to lay out and detail heating furnaces. $3380. Northern New Jersey. Y-1987.

Designer, mechanical graduate or equivalent. Must have several years' experience on single and double section and nonclogging pumps. Responsible for designing to order for pump manufacturer. $6000–$8000. Illinois. R-5272. Rewritten.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after February 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Akinci, A. H., New York, N. Y.
Aung Tun, U., Rangoon, Burma
Beale, J. G., Sydney, Australia
Bell, E. H., Urbana, Ill.
Berkowitz, J., Hoboken, N. J.
Bogardus, R. K., New Brunswick, N. J.
Brautigam, O. A., Gothenburg, Sweden
Brodoff, M. N., Bronx, N. Y.
Brown, L. J., Wilmington, Del.
Brummer, J. H., Jersey City, N. J.
Buot, Antonio, Portland, Ore.
Burrell, Frederick S., Manhattan, Kan.
Carbrey, W. L., Monroe, La.
Cave, E. W., Ponca City, Okla.
Chapin, N. A., Scotia, N. Y.
Claire, J. S., Amritsar, East Punjab, India
Clinton, H. R., Pasadena, Calif.
Cole, R. H., Evanston, Ill.
Conforti, E. D., Hartford, Conn.
Cree, Harry R., New York, N. Y.
Crumbling, John L., Wilkes-Barre, Pa.
Cummins, Andrew E., New Kensington, Pa.
D'Enis, F. B., Salisbury, So. Rhodesia, Africa
Evans, Howard J., DuBois, Pa.
Fiske, David L., Croton-on-Hudson, N. Y.
Frank, Bernard E., Rochester, N. Y.
Freeman, Newell Leslie, Schenectady, N. Y.
Frohlich, Hans, Jeannette, Pa.
Funk, Ira C., Silver Spring, Md.
Gislason, Thorsteinn, Reykjavik, Iceland
Granato, S. Joseph, New York, N. Y.
Green, Luther N., Long Beach, Calif.
Greenshields, Robert J., Wood River, Ill.
Grettom, LeRoy A., Newark, Del.
Grothe, Martin Jens, Des Moines, Iowa
Haendle, Martin D., Dansville, N. Y.
Hall, E. D., Meadville, Pa.
Hanson, Melvin A., Bloomington, Ill.
Hardin, Theron R., Hartford, Conn.
Hays, LeRoy D., New York, N. Y.
Heyel, Carl, Manhasset, N. Y.
Howell, Shelby, Jr., Amarillo, Texas.
Hoyt, E. Donald, Worcester, Mass.
Isaacson, Melvin W., Chicago, Ill.
Jones, Robert M., Biddeford, Me.
Justice, Richard Rodman, Long Beach, Calif.
Kennedy, Verne C., Jr., Evanston, Ill.
Kern, Donald Q., Brooklyn, N. Y.
Kersh, R. S., Pittsburgh, Pa.
Kidd, Charles R., Los Angeles, Calif.
Kolsky, C. G., Manhattan, Kan.
Kretzmeier, W. O., Kansas City, Kan.
Krivor, Matthew G., San Francisco, Calif.
Krueger, Herbert W., Milwaukee, Wis.
Lange, Kennard F., Chicago, Ill.
Leach, Robert W., Philadelphia, Pa.
Leland, Samuel C., East Greenwich, R. I.
Lunn, Richard B., Nashwauk, Minn.
Lunn, Wallace E., Nashville, Tenn.
MacKinnon, Gerald L., Putnam, Conn.
Maguire, Joseph P., New Orleans, La.
Martin, Howard L., Oak Ridge, Tenn.
Masnik, Walter, Schenectady, N. Y.
Maury, Henry L., Alliance, Ohio
McNair, Hugh N., Navesink, N. J.
Miller, William Field, Dallas, Texas
Moransky, Theodore, Stamford, Conn.
Mordell, D. L., Pointe Claire, P. Q., Can.
Morrison, R. George, Rochester, N. Y.
Neilson, Alan C., Worcester, Mass.
O'Donnell, Paul D., Worcester, Mass.
Oppenheim, A. K., Stamford, Calif.
Peterson, W. R., Savannah, Ga.
Rhoads, Loy D., Marion, Ohio
Roddy, Martin J., Jr., Philadelphia, Pa.
Rotter, L. C., Maplewood, Mo.
Ruth, Earl, New York, N. Y.
Scheffler, Charles E., Detroit, Mich.
Selby, John D, Albany, N. Y.
Seligman, A. M., Newark, N. J.
Simon, Lester, Boston, Mass.
Stevens, J. B., Jr., Kingsport, Tenn.
Stoudt, T. Glenwood, W. Reading, Pa.
Strange, Hubert E., Annapolis, Md.
Straub, Frederick G., Champaign, Ill.
Tait, K. G., Point Fortin, Trinidad, B.W.I.
Uber, Charles H., Youngstown, Ohio
Van Scherpe, Peter H., Jr., Fullerton, Calif.
Von Hasseln, Harold J., New York, N. Y.
Walther, George A., Cincinnati, Ohio
Walther, Lucian E., Redondo Beach, Calif.
White, Turner, Jr., University City, Mo.
Wilson, Thomas B., Jr., Philadelphia, Pa.
Wonnell, Kent B., Peru, Ind.
Yessler, Philip M., York, Pa.

CHANGE IN GRADING

Transfer to Member

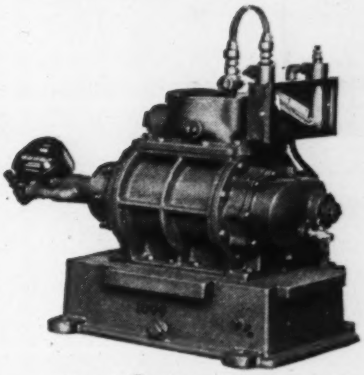
Acurso, Louis Albert, Los Angeles, Calif.
Barish, Norman N., Bronx, N. Y.
Bryan, John K., St. Louis, Mo.
Buckley, Frederick D., Fredonia, N. Y.
Chen, Hsueh Tsun, Shanghai, China.
Coutinho, John DeS., Hempstead, N. Y.
Denning, Rick A., Bronx, N. Y.
Ferrier, William John, Langhorne, Pa.
Freberg, C. Roger, Birmingham, Ala.
Gottesman, Arthur H., New York, N. Y.
Hedlund, Richard A., Plainfield, N. J.
Hudson, H. R., Atlanta, Ga.
Jones, Morris W., Providence, R. I.
Kohlhepp, Dean H., Coatesville, Pa.
Maniates, Peter G., Chicago, Ill.
Manjoine, Michael J., E. Pittsburgh, Pa.
Maybury, Richard D., Beverly Farms, Mass.
Meigs, Charles H., Washington, D. C.
Mumford, Stephen F., Lynbrook, N. Y.
Ostborg, John L., Springfield, Ohio
Petura, Richard C., Syracuse, N. Y.
Reggiori, A., Locate Varesino, Como, Italy
Smith, Dwayne C., Hickman Mills, Mo.
Stamets, Wm. K., Jr., Ithaca, N. Y.
Tullar, Irving V., Bello Monte, Caracas, Venezuela
Underberg, Samuel, Brooklyn, N. Y.
Wascher, R. P., Argo, Cook County, Ill.
West, George Thomas, Revere, Mass.
Whalen, Francis W., Houston, Texas
Wiggin, Frederick A., Lanai City, Lanai, T.H.
Wiley, Fred Edwin, Leominster, Mass.
Yorgiadis, Alexander, Greenwich, Conn.
Young, John G., Ann Arbor, Mich.

Transfers from Student Member to Junior 90

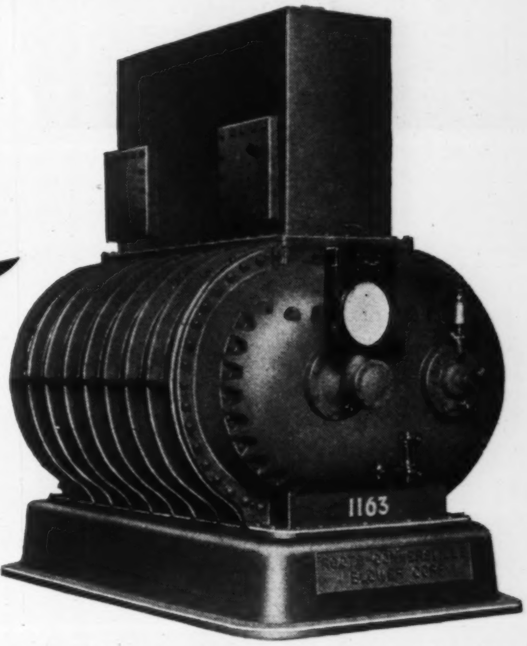
(*ASME News continued on page 198*)

MEASURE AIR OR GAS WITH

cash-register accuracy



(Above) Small-size R-C Meter with inclined differential gauge, with top inlet, and outlet in bedplate.



Large-size, low-pressure R-C Meter, side inlet box and bottom outlet, with a P.V.T.T. Recorder.

Built-in characteristics of R-C Positive Displacement Meters insure unfailing, long-time accuracy:

1. Accuracy is not affected by variations in specific gravity, rate of flow, pulsation, moisture or impurities.
2. Accuracy does not depend on uncontrollable factors.
3. Accuracy is not subject to adjustment of meter or recorder by operators.
4. Accuracy is not affected by reasonable overloads.
5. Accuracy is permanent because measuring chambers are surrounded by precision-machined cast-iron surfaces.

R-C Meters are built in 31 standard sizes, with capacities from 4,000 to 1,000,000 CFH. Indicating and recording instruments are available for all types. Send for details in Bulletin 40-B-14 or write us about your specific problem.

ROOTS-CONNERSVILLE BLOWER CORPORATION
902 Michigan Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE

BLOWER BUILDERS R-C SINCE 1854

BLOWERS • EXHAUSTERS • BOOSTERS • LIQUID AND VACUUM PUMPS • METERS • INERT GAS GENERATORS

* * **ONE OF THE DRESSER INDUSTRIES** * *

FOR HANDLING GAS OR AIR, CALL ON R-C *dual-ability*

Only Roots-Connersville offers you such an extensive line of air or gas handling equipment, including:

Centrifugal and Rotary Positive Blowers, Exhausters, Boosters

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Rotary Liquid and Vacuum Pumps

•

Positive Displacement Meters

•

Inert Gas Generators

•

For almost 100 years, our business has been the building of completely reliable air and gas handling equipment—*exclusively.*